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THE DROP FORGE AND HARDENING PLANT.

EDWARD H. McCLINTOCK.

Edward H. McClintock.

THE design and equipment of the drop forge and hardening departments—adjuncts most important to the modern manufacturing plant—are subjects frequently entirely neglected in preliminary design, and almost invariably slighted in erection. While this fact is due, without doubt, to conservatism, it is not to be denied that in few places will careful design or small investment show greater beneficial results in finished product, or quicker returns from the amount of money expended. To install an elaborately equipped tool shop, and a hardening department consisting only of a few coal and gas fires and tubs of fresh water, indicates, to the writer's mind, lack of proper thought, and is, to say the least, inconsistent. It is the object of the following article to illustrate and describe a type of each department, indicative of the writer's idea of what constitutes best modern practice, together with discussion bearing on such departments in general.

Drop Forge and Hardening Departments—Preferably Under Same Roof.

These departments, being of the same general type, should preferably be combined under one roof. In a building for this purpose, ventilation is of greater importance than light. A good form of building is from 60 to 70 feet wide by about 20 feet high under the trusses, with roof pitched not less than 30 degrees, and a ventilating monitor at least 15 feet wide extending the entire length of the building. Windows throughout should be of the American type, with sliding sashes.

In the hardening room, all windows should be protected from excessive light by slat shutters or louvres, the slats being set at 45 degrees and about 3 inches apart, adjustable for about 1 foot at the top. This arrangement gives a subdued light, enabling the hardener to distinguish his color with a greater degree of accuracy. The slight adjustment at the top is sufficient to keep the interior light even, regardless of the outside conditions. One 16 candlepower light hung 7 feet from the floor should be provided for every 150 square feet of floor space in this department.

The main illustration herewith, shows the plan of such a building as primarily laid out as a part of a large manufacturing plant. The departments, as the writer later installed them, were very much congested, owing to extremely rapid growth, and while still efficient, cannot consistently be described as best practice. In the Engineering Edition of MACHINERY for June, 1906, the writer made mention of the minimum clearances desirable in the forge shop. The equipment shown in Fig. 1 is laid out on this basis.

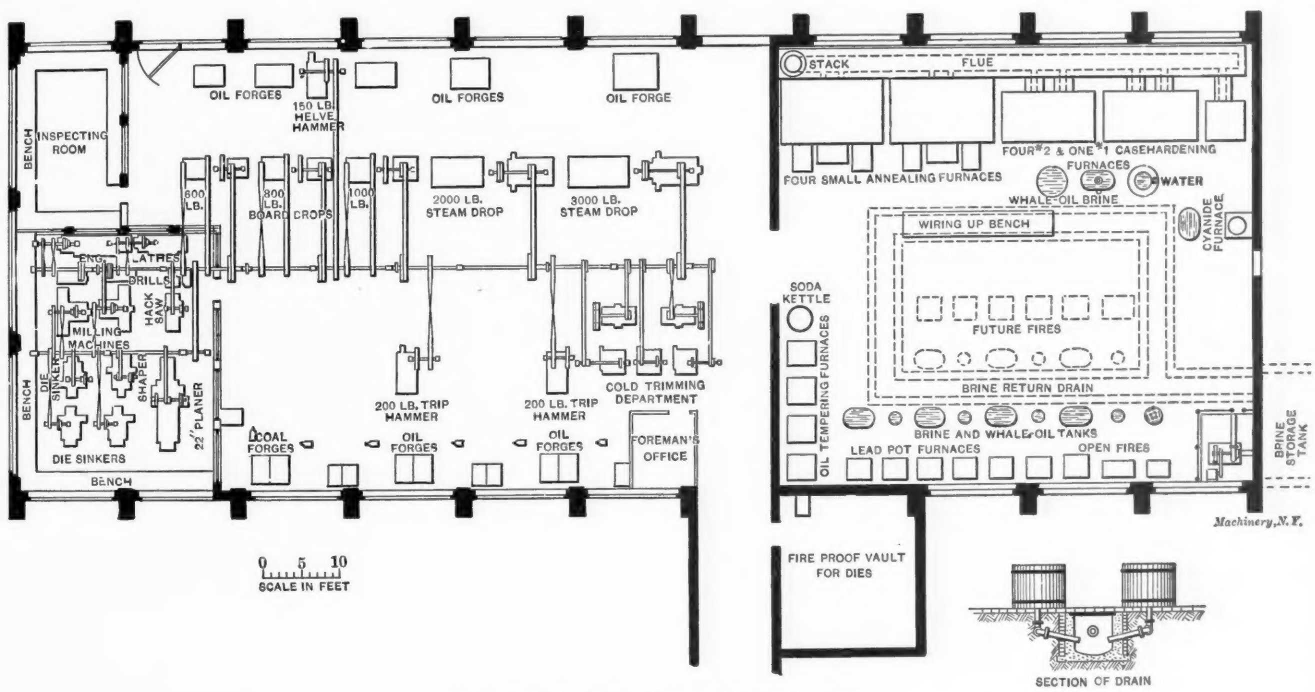

Fig. 1. Layout of Drop-forge and Hardening Shop.

Location of Die-sinking Department.

The die-sinking and inspecting departments are set in the end of the building, both to insure better light, and to be further away from the jar of the larger drop-hammers. The jar in a department so located is insufficient to materially affect the quality of the work, provided the partitions are of brick and extend well below the floor line. The rough stock for dies is to be brought in at the door near the end of the building, planed up and dovetailed in 10-foot lengths, and rough sawed to size desired in a Thompson hacksaw. The finished dies are to be stored in the fireproof vault assigned to them, on racks with shelves 8 inches wide, the dies being stored face out, one half above the other. Thirty-inch passageways, being sufficiently wide to admit single trucks, are allowed between racks.

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Board and Steam Drop Hammers; Helve and Trip Hammers.

In a moderate sized shop at least, it is the writer's policy to install comparatively large drop hammers on account of their broader range of utility. His general practice is to install board drops no size smaller than 400 pounds, and to install steam drops where the work requires sizes larger than 1,000 pounds. The steam drop in large sizes has the advantage of being able to break down its own work, but on small parts the writer's experience has been that many forgings are spoiled by catching in the quick stroke.

In the illustration, the larger board drops have been set in conjunction with a helve hammer, so arranged that it may break down for two of them. This result may be obtained equally well by setting the helve hammer between two drops and faced the same way, but with the anvil block set about 3 feet in front of the base line of the drop hammers, thus permitting the blacksmith to swing his stock directly from one to the other.

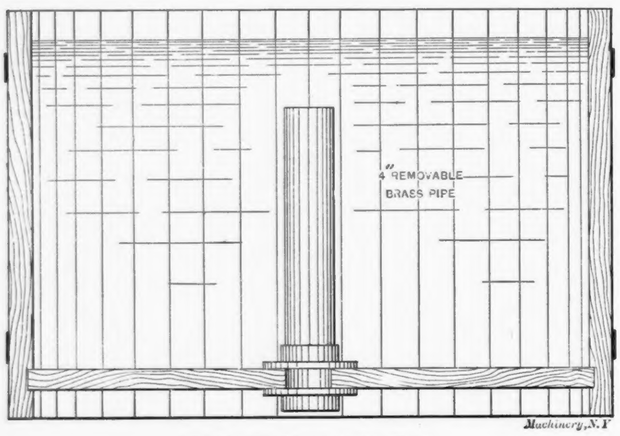


Fig. 2. Section of Brine Tank.

The larger hammers are set nearest the main cross passageways to make possible less travel for the larger stock and finished product. The forgings are, of course, hot trimmed in the trimming presses and by sprue cutters set in conjunction with each hammer, but before going to the machine shop they are accurately trimmed to the size required for their reception into their various jigs and fixtures, in the presses of the cold trimming department.

The two trip hammers are used in conjunction with tool dressing and general work. The two blacksmith forges near the die-sinking department are used for general work during the day, and for night and overtime work when the main shop is not running. They are blown from an overhead blower, motor-driven, and are hung from the trusses, their exhausts being taken out through the roof. With the exception of these two fires the use of fuel oil is universal throughout the entire shop. This subject will be further discussed later. Both the forge and hardening departments should be in general charge of one man whose office is centrally located between them, but each should have a separate sub-foreman.

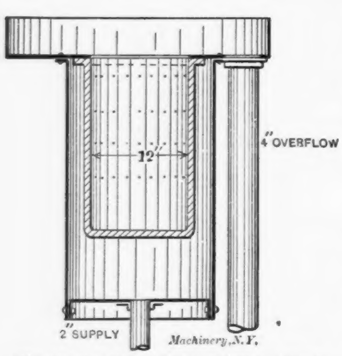


Fig. 3. Section of Special Brine Tank.

Layout of the Hardening Department.

The general layout of the hardening department is self-explanatory, but the details may require explanation. In front of the small open fires, lead pots, etc., with 45 inches clear space, is set a row of brine and whale-oil tanks, alternating, one of each kind being sufficient for two fires.

These regular brine tanks are built of 2½-inch Southern pine, and elliptical in shape, being 30 inches wide, 4 feet long, and 30 inches deep, with a capacity of 120 gallons. The brine is circulated through these tanks, entering at the bottom through a 1¼-inch brass pipe controlled by a gate valve, and overflowing at the top through a 4-inch cast iron soil pipe. The required rate of circulation for each tank to keep the brine sufficiently cool for best results in hardening, is 50 gallons per minute.

Centrally located in front of the No. 2 casehardening furnaces is a brine tank of the same size as described above, a vertical section of which tank is shown in Fig. 2. Brine is admitted through the 4-inch brass pipe in the center of the tank. This pipe extends within 6 inches of the brine level, and is readily removable by hand being loosely screwed into the coupling at the bottom. The brine entering through this pipe under pressure, forms a dome above the main level, which dome is used for the purpose of dipping the face of the drop-hammer dies, after which the dies are reheated slightly and plunged all over. By using this method of dipping the face, every corner and crevice of the die is struck at once, thereby preventing unequal cooling and cracking. As the inlet pipe is readily removable, the utility of the tank as applied to general hardening is in no way limited. One hundred and fifty gallons per minute should be temporarily available for this tank. A 5-inch cast iron soil pipe takes care of the overflow.

A 4-foot diameter whale-oil tank, one regular brine tank, and a portable fresh water tank complete the equipment required for the casehardening furnaces. These tanks are served by crane. The portable fresh water tank is 30 inches diameter by 30 inches deep, and when not elsewhere in use is set in a concreted depression in the floor, 4 feet diameter by 6 inches deep, which depression is drained through a screen by a 4-inch tile drain. The chief use of this tank is for watermarking screws and other small parts. The tank is drained at the bottom through a 2-inch spigot. A large part of the black bone used is caught by the screen in the depression, from which it may readily be shoveled out. Even with this precaution, however, it is desirable that the drain run with

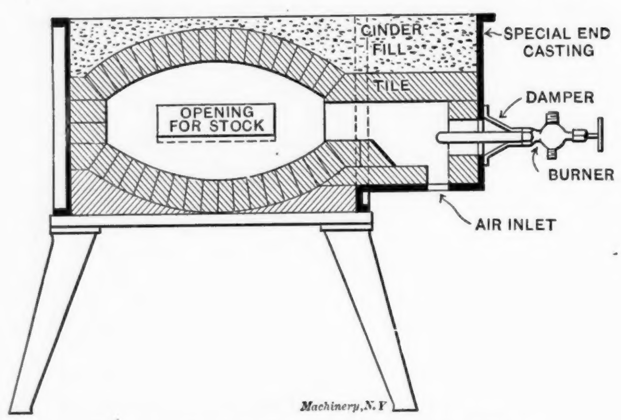


Fig. 4. Common Blast Forge Refitted to use Fuel-oil.

as steep a pitch as possible direct to a catch-basin, both to prevent stoppage and to facilitate cleaning out, should stoppage occur. The drain will surely give trouble if laid with many turns. On opposite sides of this tank are lugs or hooks to receive poles by which two men carry the tank about the job, wherever its use is required.

In front of the open fires is a special brine tank used for hardening cutters, reamers, etc. A section of this special tank is shown in Fig. 3. The brine is admitted at the bottom through a 2-inch brass inlet pipe, and spurts in through a large number of ⅛-inch holes drilled in the 12-inch cast iron inner tank. The combined areas of these small holes is designed to be about 20 per cent in excess of the area of the inlet pipe. A 4-inch cast iron soil pipe takes care of the overflow. The advantage claimed for this tank is that the brine spurting through the small holes on all sides strikes all the teeth or flutes of the cutter or reamer at the same time, thus tending to prevent cracking.

A 5-inch by 4-inch centrifugal circulating pump set in the pit in the corner of the building, and driven by a 15-horsepower motor, supplies the brine system. The required pressure which must be kept on this system to secure good efficiency is 15 pounds per square inch. The pump is set sufficiently low to be always primed from the storage tank built in the ground outside the building. That the brine may be kept sufficiently cool in the summer months, this storage

tank must have a capacity equivalent to a fifteen minutes' supply for the entire system when all tanks are in operation at full capacity. The brine overflow from all service tanks is returned by gravity to the storage tank through the open drain shown in Fig. 1.

The regular oil tanks are 20 inches diameter by 2 feet deep inside, but the shell is made 30 inches high to bring their tops at the same level as the brine tanks. The cooling apparatus consists of a coil of ½-inch brass pipe through which a part of the factory service water is circulated. The large 4-foot oil tank is of the same depth and is cooled through a

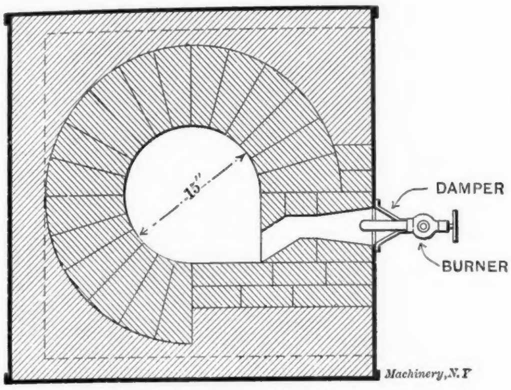


Fig. 5. Horizontal Section, Refitted Lead Pot Furnace.

1-inch brass coil. It is not necessary to keep the oil as cool as the brine. A 2-inch by 3-inch belt-driven centrifugal pump supplies the circulating water. Certain concerns cool their oil by circulating it through a series of trombone coils placed in the monitor of the hardening room, but the practice has never appealed to the writer. The expense necessitated is comparatively great, the oil makes hard work for the pump, and the main heat from the building must pass out around these coils if so placed.

Advantages of Fuel Oil.

Having in a general way described the equipment of each department, let us return to the question of fuel. The primary considerations controlling the efficiency of such departments are undoubtedly the ease of regulation and heating capacity of their fires. It is in this regard, even more than in the reduction of fuel cost, that the greatest economy is attained by the use of fuel oil. The reasons are obvious. The blacksmith's time may be given entirely to his work in hand, since once the valves are properly adjusted they require little or no attention and an even heat is assured. No labor is required to bring coal to or take ashes from the forge, and when no

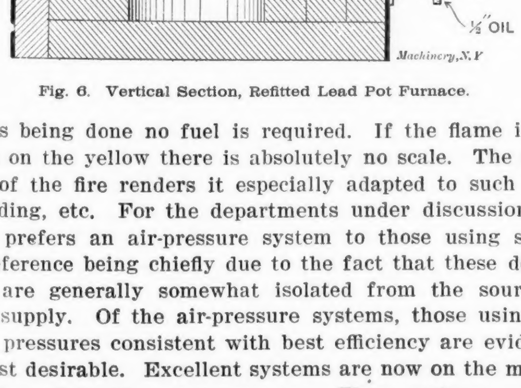


Fig. 6. Vertical Section, Refitted Lead Pot Furnace.

work is being done no fuel is required. If the flame is run a little on the yellow there is absolutely no scale. The cleanliness of the fire renders it especially adapted to such work as welding, etc. For the departments under discussion, the writer prefers an air-pressure system to those using steam, his preference being chiefly due to the fact that these departments are generally somewhat isolated from the source of steam supply. Of the air-pressure systems, those using the lowest pressures consistent with best efficiency are evidently the most desirable. Excellent systems are now on the market using from 8 to 16 ounces pressure. These systems require, however, furnaces of rather special design, the most efficient having ample combustion or mixing chambers in which the oil spray is combined with a primary air supply and volatilized before being admitted to the main chamber, where the stock is to be heated. In a plant where the installation is to be of entirely new forges, a carefully selected system of this type is ideal. In many cases, however, it may not be thought desirable to entirely discard such equipment of coal-burning forges as may be on hand. Where such is the case but small outlay is required to make the necessary alterations to permit them being used in conjuction with a moderately low-pressure system. By this the writer means a pressure of about 2 pounds per square inch, which can, of course, be readily discharged by the ordinary "high-pressure blower," without requiring the installation of an air compressor, as is of course necessary with a system using from 15 to 18 pounds pressure.

Refitted Coal Forges and Furnaces for Fuel Oil.

In refitting coal forges and furnaces to use fuel oil, it is desirable as far as possible to give the spray a whirling motion which tends to more completely vaporize the oil, and also makes a much less noisy fire than is the case where the oil strikes against flat surfaces. In the latter case, where the oil strikes flat against the white-hot tile, it causes what appears to be a series of rapid explosions sufficiently loud in a large shop to be a source of annoyance.

In Fig. 4 is shown a method of refitting a common blast forge. Common arched firebrick and skewbacks are used and a few special tiles which may readily be ground to form on the

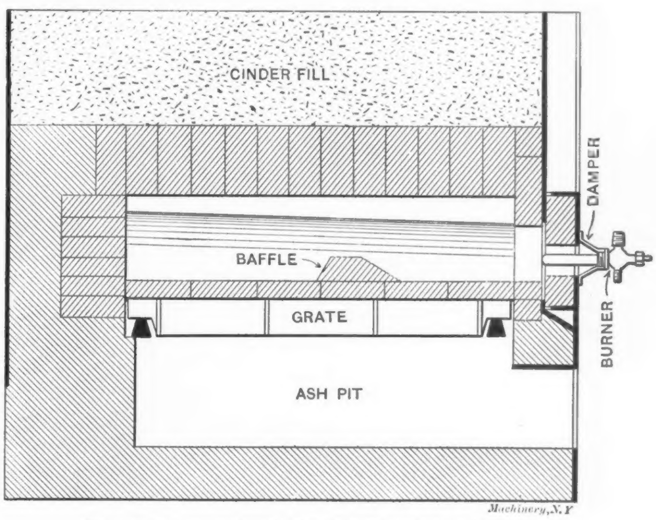


Fig. 7. Cross-section, Refitted Casehardening Furnace

common grindstone. Common red brick may be used as backing. A special casting is required, the end of which may be made to bolt onto the original side castings. In very large sizes it is sometimes advisable to install a burner at each end of the forge, which arrangement is very satisfactory and gives an intense heat at the center of the fire box.

Figs. 5 and 6 show horizontal and vertical sections of the common form of lead pot furnace refitted. Either wedge or cupola brick may be used. Two courses from the bottom tile, and forming the top of the mixing chamber, is a tile through which are drilled at an angle, six 1½-inch holes. For this operation a common star drill may, with care, be used. In the top two courses, four bricks each, are omitted at 45 degrees for vents. As before, the firebrick is backed up with common red brick.

Figs. 7 and 8 show cross and longitudinal sections of a refitted No. 2 Brown & Sharpe casehardening furnace. In this case the coal grates are left in place and simply paved with firebrick laid on their sides. A 3-inch fire tile, ground to form shown, is centrally located in the firebox to act as a baffle. If the furnace is to be set up new for use of fuel oil it is desirable that the bridge wall be sloped as shown, to leave an opening at the back of 2 inches over the wall, and 4 inches at the front. The reason for this construction is to counteract the tendency of the heat to drive to the back of the oven. This tendency exists, but it not marked, and in cases where the furnace is already set up it hardly pays to rebuild the bridge

wall. A special fire door casting, designed to take the burner, must take the place of the former vertical sliding door. These few examples will give a general idea of the changes necessary to remodel an installation of coal fires.

Arrangement of Piping.

In the two departments under discussion, the oil is supplied to all furnaces through a 1¼-inch wrought iron main, making a complete closed loop around each department in order to keep the pressure even. A 1-inch steam pipe must be laid with it to keep the oil from congealing in cold weather. These two pipes should be laid preferably in the ground itself and not in a trench, and should never be laid above the floor, the reason being that the gases from all petroleum distillates are heavier than air, and will run to the low parts of the floor or the trench. These gases, though not themselves explosive, may become so if confined with a large proportion of air.

The air piping should preferably be suspended overhead with outlets looking down into the risers from the oil mains. The speed of the air in these pipes should not exceed 15 feet per second in the first installation, which will permit of about 30 per cent increase, due to growth, without the speed becoming excessive. A rule-of-thumb measurement sometimes used is that the area of the air pipe shall equal six times the area

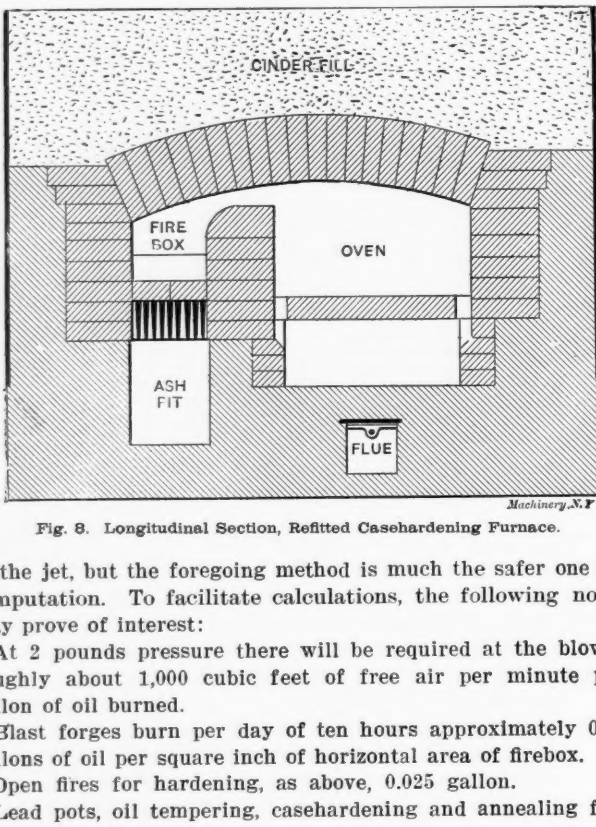


Fig. 8. Longitudinal Section, Refitted Casehardening Furnace.

of the jet, but the foregoing method is much the safer one for computation. To facilitate calculations, the following notes may prove of interest:

At 2 pounds pressure there will be required at the blower roughly about 1,000 cubic feet of free air per minute per gallon of oil burned.

Blast forges burn per day of ten hours approximately 0.15 gallons of oil per square inch of horizontal area of firebox.

Open fires for hardening, as above, 0.025 gallon.

Lead pots, oil tempering, casehardening and annealing furnaces, 0.05 gallon.

About 10 H. P. is required to transmit 1,000 cubic feet free air against 2 pounds pressure.

From the foregoing, a close estimate of the size of the required blower and the horsepower required to drive it may be obtained. Included in this estimate must be a figure on the amount of air required to blow the drop-hammer dies. The blow-pipes required are one 1½-inch pipe with flattened nozzle for each small drop and trip hammer, and two of the same size for the larger drop hammers. As the use of these blow-pipes is rather intermittent, this figure is generally in the nature of an off-hand estimate, based on the judgment of the engineer.

* * *

At a meeting of the Engineers' Club of St. Louis in January, Mr. Albert T. Perkins of the Terminal Railroad Commission stated that subways cost four times as much as elevated railroads, and quoted the following urban railway costs: Boston subway cost $2,500,000 per mile; New York subway $2,150,000 per mile; New York elevated, $500,000 per mile; New York surface lines, overhead construction, $50,000 per mile; the same lines, conduit construction, $150,000 per mile.

THE UTILIZATION OF LABOR.*

THE SCIENTIFIC SOLUTION OF THE PROBLEM.

H. L. Gantt.†

When I was invited by your president to address you, I felt a great deal of hesitancy, for the one subject to which I have given most attention, and on which I feel entitled to speak, is one that is practically impossible to study inside the college walls, and hence one with which most of you can have had but little experience. I refer to the economical utilization of labor.

The time you have spent in the study of materials and forces has undoubtedly been well spent, but the knowledge you have gained can only be utilized by human labor, and you will shortly have set you the problem of economically using human labor. To those who have done but little work outside the laboratories this probably seems a simple problem, but it is everywhere the largest problem we have to face, and is growing in importance every year. Any scheme of management, to be permanently successful, must be beneficial alike to employer and employe, and neither those labor unions that regard their interests as essentially antagonistic to that of employers, nor those employers' associations whose only effort is to oppose force by force, can ever effect a permanent solution of the problem of the proper relations between employers and employes.

Advantages of Detail Study of Labor.

Those who have given even superficial study to the subject of labor are beginning to realize the enormous gain that can be made in the efficiency of workmen if they are properly directed and provided with proper appliances. Few, however, have realized another fact of equal importance, namely, that to maintain permanently this increase of efficiency the workman must be allowed a portion of the benefit derived from it. To successfully obtain a high degree of efficiency, the same careful scientific analysis and investigation must be applied to every labor detail as the chemist or biologist applies to his work. Wherever this has been done, it has reduced expenses and, at the same time, increased wages.

The great difficulty in instituting this method of dealing with labor questions is that usually neither employer nor employe has sufficient knowledge of the scientific method to realize either the amount of detail work necessary, or the extent of the benefits to be derived from it. In general, their inclination is to adhere to the methods with which they are familiar, and to distrust all others, even though their methods have failed to bring them appreciably nearer the solution of their problems, and the newer methods have produced results far more satisfactory than they even hoped for.

The scientific laboratory for the study of materials and forces originally considered as belonging only to educational institutions, has recently become a recognized necessity in our large industries, and to it principally the great advance of recent years has been due. As yet, however, in but few cases has any definite attempt been made to study in a scientific manner the most efficient way of utilizing the human labor. Of how much work of various kinds the ordinary man has done, we have many records, but of how much a man especially suited to any class of work can do, we have almost no knowledge. Enough study has been spent on the subject, however, to determine that men especially suited to any particular kind of labor, if supplied with proper implements and intelligently directed, can do on an average at least three times as much as the average workman does.

* Abstract of paper presented by Mr. H. L. Gantt before the students of Stevens Institute, February 11, 1907.

† H. L. GANTT was born in Maryland, 1861. He graduated from Johns Hopkins University 1880 and received the degree of mechanical engineer at Stevens Institute in 1884. After graduation he was with Poole & Hunt two years, Midvale Steel Co. six years, American Steel Casting Co. one year, Bethlehem Steel Co. three years. He is now a consulting engineer engaged in reorganizing manufacturing methods and management of factories by instituting a scientific study of all their problems and adapting their methods to fit the results of such study. At present he is engaged in this work at the Sayles Bleacheries, Saylesville, R. I.

Equitable Compensation of Labor.

It has become an axiom in the commercial world that in the long run those transactions most promote prosperity which are advantageous alike to buyer and seller. It is coming to be realized in the industrial world that the same thing is true regarding the arrangements between employers and employes, and that no arrangement is permanently healthy that is not regarded as being beneficial to both. The employer who insists on more service than he pays for, and the employe who demands excessive wages for his work, both lose in the long run. The former worries continually about how to manage dissatisfied workmen that are often on the verge of a strike, and in dull times the latter lives in constant dread that his employer may no longer be able to continue business and he may be out of work.

In other words, unless efficient work goes with high wages, the result is apt to be disastrous to both employer and employe, and if we wish to have satisfied workmen we must learn how to make their labor efficient, for it is to efficient labor only that high wages can be uniformly paid. Again, if a plant is badly laid out, contains inferior or antiquated machinery, or the management is inefficient, it may be impossible for even the best workman to do an amount of work really entitling him to good wages.

Any one of these and other causes may explain why a plant whose name for years has been a synonym for prosperity has gradually become less prosperous, until to-day it can scarcely hold its own by decreasing the wages of its employes. The next stage of such plants is to close down indefinitely and to remain for years monuments to the short-sighted policy of their owners and the misfortune of their employes. The time to make provision against such a fate is not when sharp competition begins to show the need of it, but when prosperous times produce a large surplus of earnings. Out of such earnings ample provision should be made to take full advantage of all improvements in apparatus or management that are available.

When I speak of improving a plant, I do not necessarily mean enlarging it, but equipping it with the best and most efficient apparatus. When I speak of improving the system of management, I mean the elimination of all elements of chance or accident and the accomplishment of all the ends desired in accordance with knowledge derived from a scientific investigation of everything down to the smallest detail of labor, for all misdirected effort is simply loss, and must be borne either by the employer or employe.

Wherever any attempt is made to do work economically the compensation of the workman is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man and by fixing his compensation accordingly. This method, however, falls very far short of the highest efficiency, for very few workmen know the best way of doing a piece of work, and almost none have the ability to investigate different methods and select the best. It often happens then that a man working as hard as he can falls very far short of what can be done on account of employing inferior methods or inferior tools.

Setting a Task.*

We can never be certain that we have devised the best and most efficient method of doing a piece of work until we have subjected our methods to the criticism of a complete scientific investigation. Many people who have been accustomed to seeing an operation performed in a certain way, or even to performing it in that way for a number of years, imagine they know all about it, and resent the intimation that there may be some better way of doing it. Anybody, however, who carefully analyzes the sources of his methods will find that the mass of them are either inherited, so to speak, from his predecessor, or copied from his contemporaries.

Even such a simple operation as shoveling is done very uneconomically in many places. The writer has seen the same shovel used for coal, ashes and shavings, and this when coke forks were available for the shavings. The foreman had apparently given the subject no study, and was content if the men were at work. The idea of working efficiently had never occurred to him. This is, of course, an extreme case, but it is a real one, and all degrees of efficiency exist between this and the case where each workman is provided with the proper implement and given a specific task for the accomplishment of which he is awarded extra compensation.

The knowledge needed to set such a task as shoveling is much greater than is at first realized, for hardly any two substances can be treated exactly alike. In studying this subject the first element to be determined is the size of shovel, which must be gaged to hold the weight which it is most economical to handle. The second element is how long it takes to fill the shovel. For sand, fine coal, ashes, etc., it makes no difference in loading the shovel whether the material is taken from the top or bottom of the pile, but in egg coal, broken stone, or lump ore the difference is very great; for, while it is quite easy to get a full shovel from the bottom of the pile which rests on a smooth, hard surface, it is in some cases practically impossible to fill a shovel from the top of the pile without actually raking the material on to the shovel. Again the distance or height to which the material is thrown is a factor in all cases, not only because the higher or longer throw takes more time, but because it takes more energy.

This analysis shows that each such operation may be divided into a number of elements which may be studied separately. Having studied each element, the results may be combined in a number of ways to show the time needed to fill and empty a shovel with different materials under a variety of conditions. Knowing the time needed for an operation we can add the percentage of the time needed for rest, etc., which has been determined, and calculate just how many shovelfuls a good man can average per minute without overexerting himself.

Doing the Task.

Having determined thus the amount of work that a man can do, we can usually get it done if we offer the proper wages for doing it, and furnish an instructor who will teach the workman how to do it. If the best method is taught to a capable workman to whom good wages are paid for its successful operation, it would seem that we had done enough to assure the work being done that way permanently. Such, however, is not the fact, for while these conditions will usually produce the desired result, they will not always maintain it, but must be supplemented by a fourth condition, namely, a distinct loss in wages on the part of the workman unless a certain degree of efficiency is maintained.

The importance of maintaining a definite degree of efficiency is readily understood when we consider that a properly equipped plant has only its proper complement of each kind of machine, and if the output of any one falls below a certain amount the output of the whole plant is diminished in proportion and the profits fall off in a much greater ratio. This fact does not appeal to the workman who has made good wages for several days and concludes to "take it easy" for a while, unless *he* also feels the loss his "going easy" causes his employer.

In order to get the best results the following four conditions are necessary:

First: Complete and exact knowledge of the best way of doing the work, proper appliances and materials.

Second: An instructor competent and willing to teach the workman how to make use of this information.

Third: Wages for efficient work high enough to make a competent man feel that they are worth striving for.

Fourth: A distinct loss in wages in case a certain degree of efficiency is not maintained.

These four conditions for efficient work were first enunciated by Mr. Fred W. Taylor, and when they are understood their truth seems almost axiomatic. They are worthy of a very careful consideration.

Scientific Investigation.

The first condition is an investigation of how to do the work and how long it should take. The fact that any operation, no

* Task is not here used in the old sense of meaning a specific amount of labor imposed or required under penalty, but in the sense of being a certain definite allotment of work set up as a standard and which if accomplished in less time results in an increase of pay inasmuch as more tasks are completed in a day. The setting of a task is an important part of the work of the planning department in the Taylor system of works management, and is done only after a thorough investigation of all the factors affecting the task.—EDITOR.

matter how complicated, can be resolved into a series of simple operations is the key to the solution of many problems. Study leads us to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study.

This is recognized at once as simply the ordinary scientific method of procedure when it is desired to make any kind of an investigation, and it is well known that until this method was adopted science made practically no progress. The ordinary man, whether mechanic or laborer, if left to himself, seldom performs any operation in the manner most economical either of time or labor, and it has been conclusively proven that even on ordinary day work a decided advantage can be gained by giving men instructions as to how to perform the work they are set to do. It is perfectly well known that nearly every operation can be, and in actual work is, performed in a number of different ways, and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method.

Mr. Fred W. Taylor, who was the pioneer in the work of elementary time study and rate fixing which involves complete detailed instructions for doing work, began on these lines in 1880, and soon became convinced that they were correct. He has fixed a large number of rates, all of which are lower than those usually paid, but as he takes care to furnish the best implements for doing the work, and insists that the work shall be done as he instructs, the good men always make better wages than they can where they are allowed to do the work with the implements and in the manner they see fit. His piece rates, doing justice both to the employer and the employe, have produced not only a much greater output than any other method in the works where they have been introduced, but a much better feeling among the men towards their employers. The fact that during the past twenty-six years a great many such rates have been introduced, always with the same result, is a confirmation of the correctness of the principles on which they are based, and leads us to the conclusion that a strict adherence to these principles and a desire on the part of employers to do substantial justice to their employes, would in a short time materially lessen the antagonism between them and their workmen.

To analyze every job and make out instructions as to how to perform each of the elementary operations requires a great deal of knowledge, much of which is very difficult to acquire; but the results obtained by this method of working are so great that the expenditure to acquire the knowledge is comparatively insignificant. It would not be possible for me to give you much idea from this platform as to how to do this work. I can, however, tell you of some of the results that have been accomplished.

In the first column in the following table is given the time needed in the machine shop of the Bethlehem Steel Co. to rough turn work before any study had been made; in the second column is the time it took after the proper study had been made, and the conditions adjusted to meet the results of the study.

4-in. U. S. Navy Tubes	21.56	5.4	4
4-in. U. S. Navy Jackets	35.15	7.1	5
6-in. U. S. Navy Tubes	34.75	8.25	4
8-in. U. S. Navy Tubes	35.00	8.00	4.4
12-in. U. S. Navy Tubes	54.50	21.50	2.5
12-in. U. S. Navy Jackets	123.70	43.33	2.6

In the third column is given the ratios of work done per hour. The average of these is 3.75.

All the labor of handling pig iron, coal, coke, ore and open hearth melting stock in the yard of the Bethlehem Steel Co. was studied in the same manner, and the amount done per man on piece work after the study averaged 3.2 times as much as was done before. In the Sayles' Bleacheries where I am now at work, I find similar ratios. This means that whether the labor is that of a Pennsylvania Dutch workman in a machine shop, a Hungarian laborer handling stock in the yard of a steel works, or a skilled cloth handler in a bleachery, the amount of work the average workman does under the ordinary conditions is only about one-third of what can be done by a workman under the best conditions.

Instructions.

As a result of our first step, or our scientific investigation, we in general find that it is possible to do about three times as much as is being done; the next problem is how to get it done. First I wish to say that no matter how thoroughly convinced we may be of the proper method of doing a piece of work and of the time it should take, we cannot make a man do it unless he is convinced that in the long run it will be to his advantage. In other words, we must go about the work in such a manner that the workman will feel that the compensation offered will be permanent.

When we have established this condition of affairs, we are ready to start a workman on the task, which, when properly set according to our investigation, can be done only by a skilled workman working at his best normal speed. The average workman will seldom be able at first to do more than two-thirds of the task, and as a rule not more than one out of five will be able to perform the task at first. By constant effort, however, the best workmen soon become efficient, and even the slower ones often learn to perform tasks which for months seemed entirely beyond them.

If we have at hand such people that already have confidence in us and are willing to do as we ask, the problem of getting our task work started is easy. This, however, is frequently not the case, and a long course of training is necessary before we can teach even one workman to perform his task regularly, for workmen are very reluctant to go through a course of training to get a reward, especially when they fear that the high price will be cut when they can earn it easily.

Compensation of Labor.

Buying labor is one of the most important operations in modern manufacturing, yet it is one that is given the least amount of study. Most shops have expert financiers, expert designers, expert salesmen and expert purchasing agents for everything except labor. The buying of labor is usually left to people whose special work is something else, with the result that it is usually done in a manner that is very unsatisfactory to buyer and seller. It is admitted to be the hardest problem we have to face in manufacturing to-day, and yet it is only considered when the manager "has time," or has "to take time," or on account of "labor trouble." The time to study this subject is not when labor trouble is brewing, but when employer and employe have confidence in each other.

Men as a whole (not mechanics only) prefer to sell their time rather than their labor, and to perform in that time the amount of labor they consider proper for the pay received. In other words, they prefer to work by the day and be themselves the judges of the amount of work they shall do in that day, thus fixing absolutely the price of labor without regard to the wishes of the employer who pays the bill. While men prefer as a rule to sell their time, and themselves determine the amount of work they will do in that time, a very large number of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done, and paid substantial additional amounts of money for doing it. The additional amount needed to make men do as much work as they can depends upon how hard or disagreeable the work is and varies from 20 to 100 per cent of their day rate.

If the work is light and the workman is not physically tired at the end of the day he will follow instructions and do all the work called for if he can earn from 20 to 30 per cent in addition to his usual day's wages. If the work is severe and he is physically tired at the end of the day he requires from 40 to 60 per cent additional to make him do his work. If in addition to being physically tired he has been obliged to work under disagreeable conditions or in intense heat, he may require 70 per cent or even 100 per cent addi-

tional. These facts are derived from experience and give us a key to the intelligent purchase of labor. If we wish to buy the amount of labor needed to accomplish a certain task, we must find out exactly and in detail the best method of doing the work, and then how many hours' labor will be needed by a man suited to the task working at his best normal rate. This is simply getting up a set of specifications for the labor we wish to buy, and is directly comparable to a set of specifications for a machine or a machine tool. The man who buys the latter without specifications is often disappointed even though the manufacturer may have tried earnestly to anticipate his wishes; and the man who buys the former under the same conditions has in the past almost universally found that a revision of his contract price was necessary in a short time. The relative importance of buying labor and machinery according to the best knowledge we can get, and the best specifications we can devise, is best illustrated by the fact that while the purchase price of a machine may be changed whenever a new one is bought, that of the labor needed to do a piece of work should be permanent when it is once fixed.

As I have said before, few men can work up to these specifications at first, if they are properly drawn, but many men will try if they are properly instructed and assured of the ultimate permanent reward. Most men will not sacrifice their present wages to earn a higher reward in the future, and even if they were willing few men could afford to. Therefore, while they are learning to perform the task, they must then be able to earn their usual daily wages, and the reward for the accomplishment of the task must come in the form of a bonus over and above their daily wage.

Task Work with a Bonus.

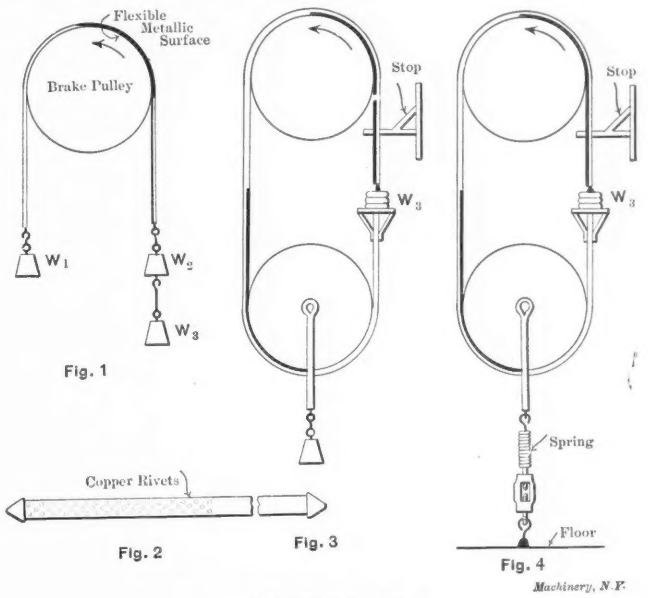
It is these considerations that lead to the development of the bonus system of paying labor, under which a man always gets his day's wages, and if he accomplishes the task in the time and manner specified, he is paid a bonus the size of which depends upon the severity of the work. The easiest way to figure such a bonus is to make it a proportion of the time allowed; for instance, if from our time study we find that three hours is a reasonable time for a job that has usually taken from five to ten hours, we set three hours as the time limit and pay the workman one-third more, or for four hours, if he does the work in three hours or less. If he does it in exactly three hours he gets pay for four hours or an increase of 33 1-3 per cent. If the work is done in 2½ hours he gets pay for four hours or an increase in wages per hour of 60 per cent. If the work is done in two hours his pay is still that which he would ordinarily get for four hours, an increase of 100 per cent. If the study of the work has been carefully done, and the task is properly set, it will but seldom occur that a workman can do in two hours the task for which he was allowed three. We sometimes find, however, that an exceptional man will do in 2½ hours' work what a really good man will need three hours for. The large increase of wages such a man can earn amply compensates the exceptional man for devoting his time to the work.

The increase in efficiency makes the payment of high wages possible, and it may be added that without efficient labor, permanent high wages cannot be paid indefinitely, for *every wasteful operation, every mistake, every useless move has to be paid for by somebody, and in the long run the workman has to bear his share.* Good management, in which the number of mistakes is reduced to a minimum, and useless, or wasteful operations eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. In other words, that management is best which utilizes labor in the most efficient manner. The best mechanical equipment of a plant that money can buy avails but little if labor is not properly utilized. On the other hand, the efficient utilization of labor will often overcome the handicap of a very poor equipment, and an engineer can have no greater asset than the ability to handle labor efficiently.

A SELF-REGULATING BRAKE.

The inconvenience and uncertainty involved in hand regulation of the common prony brake has led to the development of a simple automatic device, described in the *Electrical Journal*, which is well adapted for motors of small power.

The scheme of loading is a familiar one and is shown diagrammatically in Fig. 1. The equal weights W_1 and W_2 supply the tension that makes the strap grip the pulley and the torque thus developed is balanced by the weight W_3. The automatic feature of the device consists in the special construction of the strap used. It may be made of any flexible material with a good friction surface, but from its center to one end it should be provided with a flexible metallic surface on the side that is to face the pulley. Such a strap may be readily made from a piece of leather belting studded with copper rivets as indicated in Fig. 2. For accuracy at light loads the belt must be quite flexible. The operation of the device is apparent from the sketch. W_3 is placed on the end of the strap provided with the metal surface and hung from the rising side of the brake pulley. If the torque developed overbalances W_3 this weight will rise and the strap shift on



Self-regulating Brake.

the pulley, until more copper and less leather are in contact with the pulley rim. This lowers the average coefficient of friction to a point that will just balance W_3, so that the amount of this weight determines the torque to which the brake will adjust itself. The difference in the friction coefficients of leather and copper is so large that a wide range of torque may be provided for without changing W_1 and W_2.

For example, in one test with a 1-inch strap on a 4-inch pulley, with W_1 and W_2 each ½-pound weights, it was found that on changing W_3 from ½ to 5 pounds, the belt moved only about 2½ inches. This was a ratio of 1 to 10 which is ample, as the usual range in shop testing of motors is from one-fourth to one and one-half full-load, or one to six.

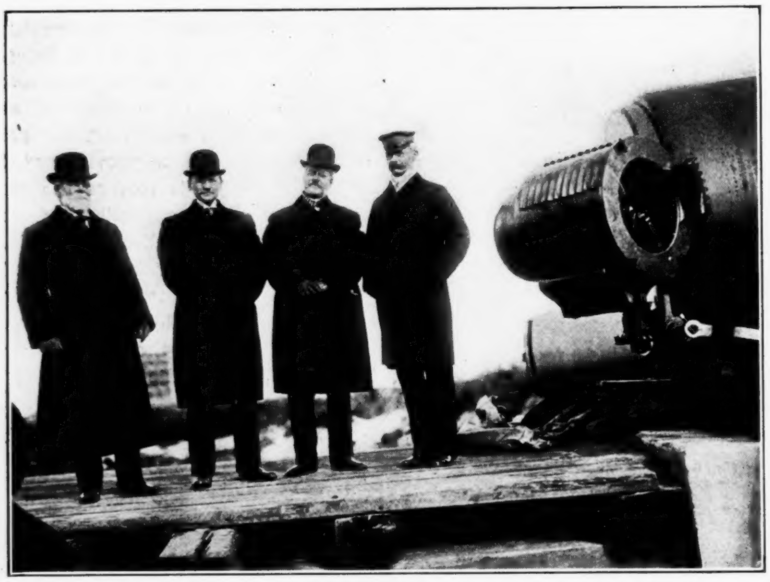
The automatic feature of this device takes care of all changes in the friction surface due to variable temperature and other causes. This fact was quite effectively demonstrated in a test on an experimental brake in which oil was applied to the brake pulley while running. The oil simply caused the belt to shift to a new position where it continued to operate as before.

For very accurate work on small motors it may be worth while to balance the strap by making it a continuous belt with two "rivet patches" so placed as to balance each other. In this case the weights W_1 and W_2 may be replaced by a light pulley carried in the lower loops of the belt, and the desired tension obtained by a single weight or by a spring or other mechanical take up as shown in Figs. 3 and 4. But in ordinary work the simpler scheme is sufficient.

In figuring results it must be remembered that the brake arm is not the radius of the brake pulley, but exceeds this by one-half the thickness of the belt.

VISIT OF THE MECHANICAL ENGINEERS TO SANDY HOOK.

In our February issue, under the caption "A Mid-winter Picnic at Sandy Hook," we described the visit made by the American Society of Mechanical Engineers to Fort Hancock and the Proving Grounds last December. In Fig. 1 is shown a photograph which was mentioned in that article as having been taken at the time. The four men standing on the loading platform behind the temporary mounting of the 16-inch gun are (reading from left to right) Brigadier General Murray, of the General Staff of the United States Army; Fred. W. Taylor, president of the American Society of Mechanical Engineers for last year; Prof. F. R. Hutton, this year's president; and Brigadier General Crozier, Chief of Ordnance. The fifth celebrity at the extreme right is the gun itself, whose breech block is shown unlocked, withdrawn, and swung out of the way ready for loading.



Brig. Gen. Arthur Murray. Fred. W. Taylor. Prof. F. R. Hutton. Brig. Gen. Wm. Crozier. Sixteen-inch B. L. Rifle.

Fig. 1. Five Big Guns.

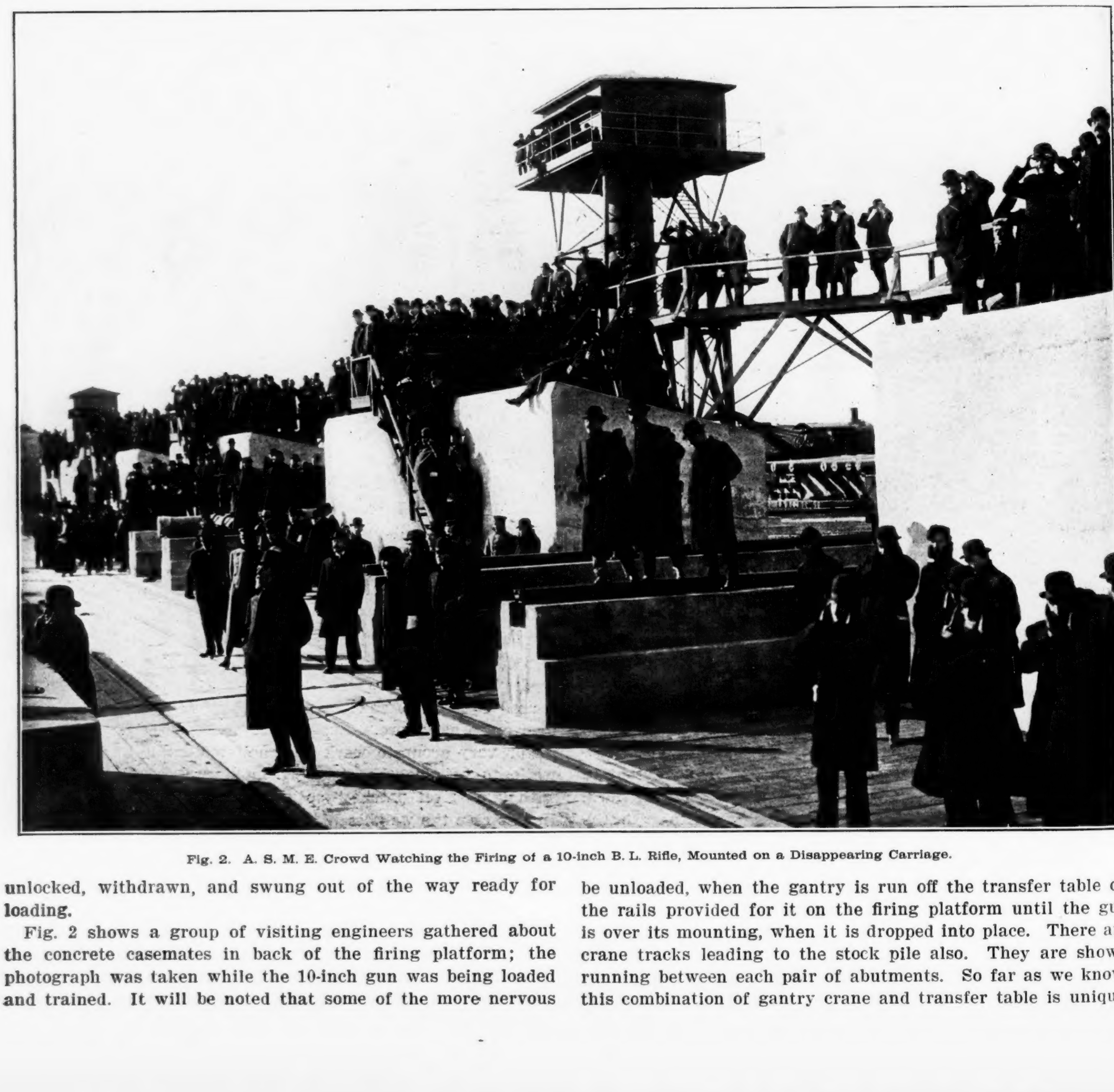


Fig. 2. A. S. M. E. Crowd Watching the Firing of a 10-inch B. L. Rifle, Mounted on a Disappearing Carriage.

Fig. 2 shows a group of visiting engineers gathered about the concrete casemates in back of the firing platform; the photograph was taken while the 10-inch gun was being loaded and trained. It will be noted that some of the more nervous of the visitors in the foreground have already got their fingers in their ears.

The crane service for this firing platform is unusual and effective. At the left are the concrete foundations for the rifles, mortars, howitzers, etc., large and small. In the background, beyond the concrete bulwarks, is the storage space for the ordnance. At the left of the picture and in the rear, at the further end of the line of bulwarks, runs a railroad track which brings the guns from the outer world. A gantry crane is used. It may be run onto a transfer table which rolls on the outer two of the four rails shown in the tracks running from the foreground toward the rear. If it is desired to pick a rifle from a car, the crane is run onto the transfer car, rolled down until it is over the track, run over the flat car, and the load is hoisted. It is then run back onto the transfer table, which is moved to a position opposite the point where the rifle is to be unloaded, when the gantry is run off the transfer table on the rails provided for it on the firing platform until the gun is over its mounting, when it is dropped into place. There are crane tracks leading to the stock pile also. They are shown running between each pair of abutments. So far as we know, this combination of gantry crane and transfer table is unique.

AUTOMOBILE ENGINE BUILDING IN A STEAM ENGINE PLANT.

The business of the Providence Engineering Works, of Providence, R. I., is ordinarily that of building heavy mill and power plant engines. During a temporary lull in this line, two years ago or thereabouts, the management of the firm decided to take on some contract work. Arrangements were accordingly made with the Maxwell-Briscoe Motor Co to manufacture about two thousand double-opposed-cylinder automobile gas engines, with the accompanying speed change mechanism, differential gearing, and other related parts.

A period of careful planning and hard work followed the signing of this automobile engine contract. New machinery had to be purchased at a time when it was almost impossible to get machinery of the kind required. New workmen, skilled in special operations, had to be hired at a time when good workmen were being bid for in a very lively fashion. Difficulties of this sort, however, were overcome with a little time and patience. Meanwhile the superintendent, shop foreman, and an expert tool designer, set themselves to the task of carefully going over the detail drawings of the engine they were to manufacture, taking up each part in turn and deciding on the order of operations for each, and the tools that were to be used on it. After due conference on the matter an operation sheet was written up for each piece, giving in the first column the number and name of each operation performed, no matter how simple; in the second column the holding tools required for that operation, such as jigs, fixtures, clamps, etc.; in the third column the cutting tools used in the machine; and in the fourth column the testing gages and devices used by the inspector.

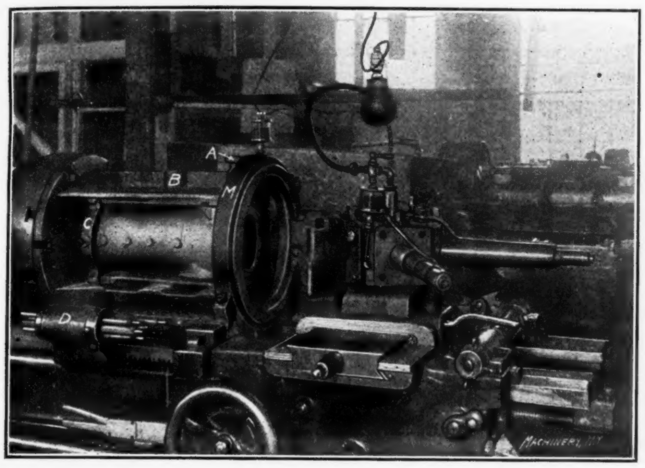


Fig. 1. Reversible Revolving Fixture for Boring Crank and Transmission Cases.

In cases of this kind there is a great temptation to commence work before such elaborate preparations as those just outlined have been completed. With the customer anxious for finished work at the earliest possible moment, and with what appears to be a heavy non-productive preparatory expense staring the management in the face, it takes some courage to refrain from trying to start production with the usual haphazard ways of working. It must be admitted that this temptation was yielded to in a slight degree. In the matter of test tools, for instance, the pressure on the drafting room and toolmaking force was such that production had commenced before the measuring devices were completed, so that the inspectors were left in many cases to somewhat clumsy, though accurate methods of passing on work performed. In general, however, it may be stated that the ideal of thorough preparation was conscientiously held to.

Simultaneously with this work of determining the manufacturing methods, there was developed a system of cost keeping simple enough to be practicable, and yet complete enough to inform the management at any time as to the exact cost of each part and the comparative cost of the same part in different lots. The system also kept account of all the stock and castings used, leaving no chance for spoiled work to escape attention, and always assuring the full complement of parts when a lot was to be assembled. A great factor in making this last item possible was the thorough inspection planned for, which required that every individual part be tested after each operation, or group of related operations. With this precaution, the expenditure of costly work on already spoiled pieces is avoided, and provisions can be made for replacing spoiled work before it reaches the assembling room, where a shortage will often cause a very costly delay.

It was impossible, in the comparatively short time the writer was able to spend at the plant, to see all the interesting methods of manufacture involved, and it is still more impossible to describe them in the limited space at his disposal in this journal. The best that can be done, perhaps, is to describe a few of the operations which particularly attracted the writer's notice, and let the reader judge therefrom as to the nature of the rest of the work.

The engine called for in the contract is of the double opposed cylinder type, with a crank case and transmission gear case in one piece. The cam shaft is driven from the crankshaft by spur gearing, and is journaled in a frame which also carries the tappet rods and their springs, by which the valves are operated. The arrangement of the mechanism is such that a single inlet cam and a single exhaust cam serve to control the valve movements of both cylinders. The frame containing the mechanism is bolted to the top of the crank case, and may be quickly removed entire, thus affording access to the crank chamber. The speed changing mechanism is of the epicyclic type, giving two forward speeds and one reverse. The clutch is of the multiple disk design, running in oil. All this mechanism forms a complete power unit; the complete structure is supported on a three-point bearing, the cylinders being supported at their heads by the side bars, while the rear end of the transmission case rests on a cross brace of the frame. This design assures permanency of alignment as well as simplicity of construction.

The gear and crank casing, which is of aluminum, first undergoes a milling operation for the cover and for the bolting on of the plate by which the speed changing levers are held.

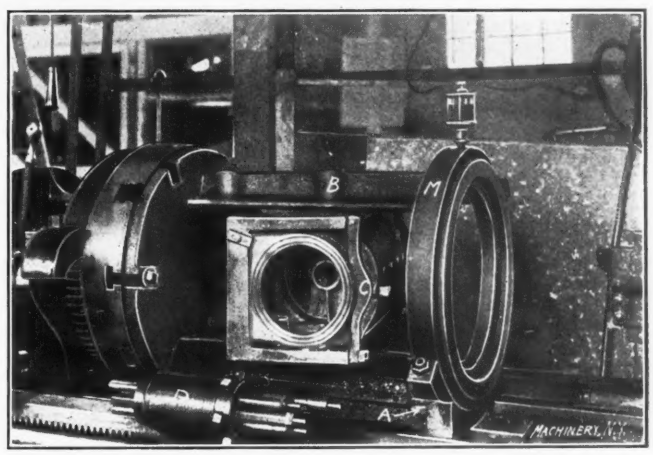


Fig. 2. Work being Swung End for End in Boring Fixture.

This operation leaves a square finished corner whose sides are used as gaging surfaces for subsequent operations. The crankshaft is journaled in a bearing cast integral with the case near its center, the outer ends being supported in bearings in two heads which are clamped to seats finished for them. The boring and facing of the boss for the central bearing and of the seats for the heads or covers at either end, is accomplished in an ingenious fixture attached to the faceplate of a heavy Bullard turret lathe. This fixture is shown in Figs. 1 and 2. The work is held by its finished surfaces with hook bolts and is lined up by suitable setscrews. Straps *C C* are swung over the top of the case, and the setscrews which they carry are brought lightly down on top of the work. The outer end of the fixture is carried in the steady rest *M*, which is clamped to the bed of the lathe. The following operations then are performed. First, at the cylinder end a single pointed boring tool is run through the boss for the central bearing. The hub is then faced and the hole chamfered to form a true starting surface for the 4-lipped drill which is located in the next station of the turret. The

third and fourth operations are the roughing and finishing cuts for boring, facing and grooving the flange at the cylinder end. The blades for this are set in heavy cast-iron holders, one of which is in position for action in Fig. 1.

The cylinder end having been finished, the unique feature of the fixture comes into play. The locating pin *A* is withdrawn and the whole transmission case casting, with the fixture in which it is held, is revolved about a vertical axis passing through pivots *B*, until the transmission end is brought to the front to be worked on. This change of ends is shown half completed in Fig. 2. The other end of the hub is now faced, and the flange at the transmission end is finished with the same tools used for the crank end.

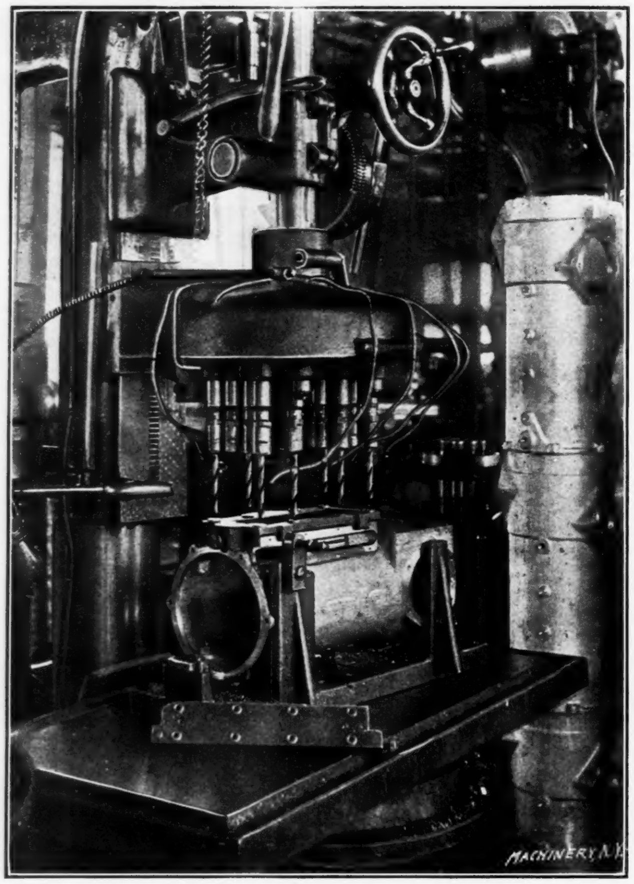


Fig. 3. A Multiple Spindle Drilling Head arranged for Two Lay-outs.

The steady rest, as shown, is provided with a sight feed lubricator. Some little difficulty was experienced at first with the bearing at this point; the final and successful form of bearing was cast-iron running on babbitt, with overhanging lips provided on the journal on each side of the bearing, to prevent intrusion of chips and grit. Fastened to the ways in front of the fixture will be seen a series of stops inserted in a revolving holder *D*. These are used for determining the length of cut for the various operations.

One of the succeeding operations on this part is shown in Fig. 3. A multiple spindle drilling attachment is there shown, attached to a Prentice drill press. This attachment was built by the Langelier Mfg. Co., of Providence, R. I.; it is of interesting construction though in no sense new. We may at a later date show something of its details. The interesting feature of this particular multiple spindle drilling attachment is the fact that it was built for two operations. As shown, it is set up for drilling the bolt holes for the cover plate. There are, however, it will be noted, two inner rows of spindles which are not being used. These are employed for a later operation, the drilling of the bolt holes for the slide cover shown near the top of the front side of the casting; the bushing plate for this is lying on the drill press table in the foreground of Fig. 3. One attachment at a moderately increased cost thus serves for two operations. In a similar way the two end flanges and the cylinder clamping surfaces are drilled with a second attachment, having for this purpose two rows of holes, only one of which is used at a time.

The fixture and tools shown in Fig. 4 were first passed by the writer without particular notice, although their purpose had been fully explained to him. After a night's meditation on the subject, however, the ingenuity of the idea involved in this fixture grew upon him to such an extent that he returned the next day for the photograph from which the cut was made. The operation being performed on this drill press comes next after the snagging. It has as its object the finishing of certain locating surfaces to be used in boring the cylinder. These surfaces must so locate the cylinder in the boring operation that the comparatively thin wall left will be of uniform thickness throughout the circumference at both top and bottom ends of the cylinders, and so, also, that the facing of the cylinder flange where it is attached to the crank case, will be such a distance from the rough rear cylinder end, that there will be the same compression space in each cylinder. The rough casting shown on the drill press bed at the left of Fig. 4 has set within it a templet whose lower end rests on the rough bottom of the cylinder. On the chalked outer edge of the hexagonal flange by which the casting is bolted to the casing, is scribed a line which coincides in its vertical location with the under edge of the overhanging lip of the templet. After this edge has been scribed, the casting is reversed and placed in the fixture under the drill spindle, as shown. This fixture consists of a base with an adjustable bottom plate and a series of brackets around the outside. The vertically adjustable seat on which the casting rests is moved up or down by a nut beneath the base of the fixture until the tapered point of a locating pin coincides with the line which was scratched on the casting from the templet, as previously described. There are also a series of locating pins *F*, eight in all, mounted at the top and bottom of the casting in brackets cast integrally with the bed. These pins may be clamped in position by the winged head screws shown. They all carry similar locating marks, which should line up with corresponding marks in recesses cut in the hubs which carry them, if the casting is central in the fixture and is of normal size.

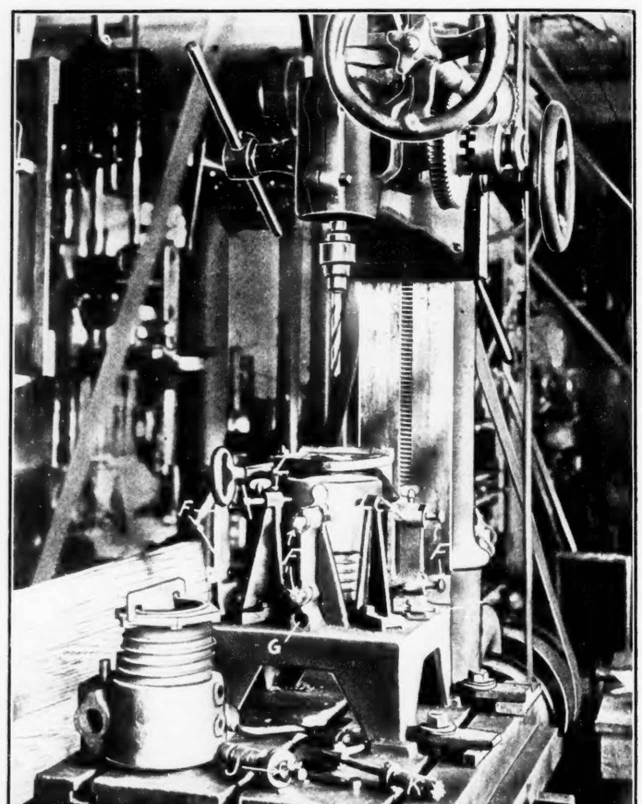


Fig. 4. Laying Out Templet and Spotting Fixture for Cylinders.

In locating a cylinder then, it is first adjusted vertically until the line scribed by the templet comes opposite the point of the gage pin; then it is centered at the bottom by

pushing in the various pins F until the marks on them line up with those on the jig (or until they are all equally out of alignment), when they are clamped by the thumb screws. This operation is repeated with the upper locating pins F, and the supplementary clamping screws L, on the intermediate brackets, are then brought down on the work to hold it more firmly. The hinged cover shown is next swung over, and a hole is drilled through into the top of the cylinder. The boss in which this hole is located is then faced by the counterbore J shown on the table below. This counterbore has a stop collar clamped to it to determine the depth of cut. The hole is intended primarily for the suspension bolt by which the cylinder is fastened to the frame, but its immediate use is, by its location, to fix the upper end of the cylinder in the subsequent boring operations; and by the depth of the counterboring of its hub, to determine the depth of the clearance space. At G, in the base of the front bracket, and in one of the intermediate brackets to the rear of the machine, are holes for guiding the hollow mill held in the bit-brace K, shown in the drawing. This hollow mill carries a stop which comes up against the face of the boss through which it passes, and limits the depth of the cut which may be made with it; the tool is, of course, worked by hand. It spots flats on two of the six corners of the hexagonal flange of the cylinder. These spotted off corners are used in lining up the outer end of the cylinder in the boring operation, which is thus assured of being properly done so far as the outer end is concerned. This device is, in fact, a laying out fixture rather than simply a drilling jig for the simple operation

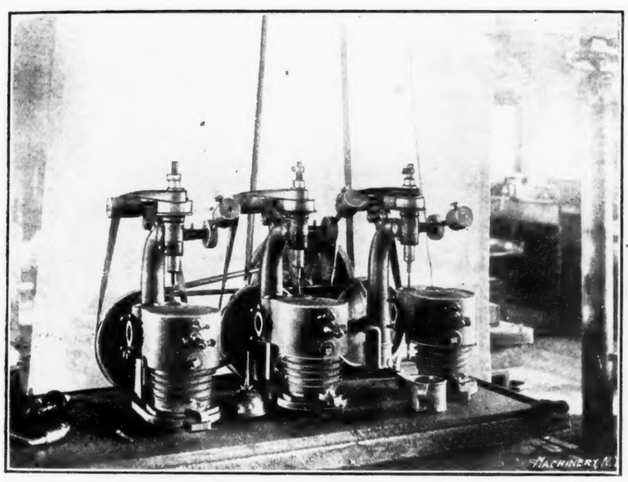


Fig. 5. Novel Machine for Grinding in Valves.

performed. Upon the location determined by it depends all the subsequent work done on the cylinder.

In Fig. 5 is shown a little device for grinding in the valves. This arrangement looks like a 3-spindle gang drill when at rest, and if the observer has once come to the conclusion that this is the case, the action of the rig when the shipper rod is thrown over is surprising—almost ridiculous even. Instead of whirling straight ahead as well-educated drill spindles should, those of this machine run in one direction for a few turns, then turn around and hurry backwards again, and so on. This reciprocating rotary motion is, of course, just what is required for grinding the valves to their seats. Each spindle carries a screwdriver-like implement at its lower end which engages a slot in the top of the valve stem. The belts which rotate the spindle back and forth are carried over the large pulleys at the rear, which are in turn given a reciprocating rotary movement by the driving pulley and connecting rod shown. But three of the six machines used on this bench appear in the cut. The man who formerly spent weary hours at the bench grinding in these valves with a bit-brace, is said to have become really cheerful under the new dispensation, where he has only to put the parts under the machine, put in a little oil and emery, and watch it do the work.

Considerable ingenuity is shown in the making of the pistons and piston rings. The pistons are finished on a Gridley turret lathe and are chucked by their rough inside surfaces in such a way as to bring the thickness of metal about the same all around the circumference. The chuck for this purpose is shown in Fig. 6. The piston is gripped by six pins which expand outwardly, three at the front and three at the rear. The bosses for the connecting rod pin interfere with placing these pins 120 degrees apart, but they are spaced as nearly that way as possible. It was not desired to have separate movements required for tightening the work at the front and back, so a floating device is used for clamping the work which, with but one movement, assures

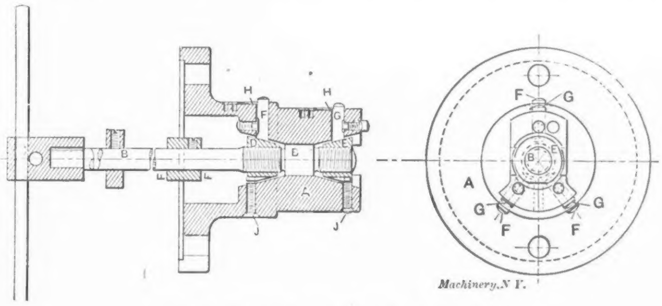


Fig. 6. Floating Grip Chuck for Piston.

the simultaneous outward movement of the six pins and gives an equal distribution of clamping effect between the front and rear groups. As will be seen in Fig. 6, the pins are moved outward by the tapered nuts D and E, threaded one right hand and the other left hand, on the closing rod B, which passes through the center of the spindle and ends in the cross handle C at the rear. Flat springs H normally keep the pins pressed down on these wedges. Suppose a piston is placed on the nose of the fixture. When the clamp rod is turned, the outer row of pins, G, may possibly open first. These will continue in their outward movement until they strike the rough interior of the piston, which is thereby centered at the front end. When the outward movement of these pins is thus arrested, the continued rotation of the clamping screw threads it into the outer tapered nut and thus brings the inner tapered nut toward the right, moving outward the three pins T of the second row. These in turn advance until they strike and center the rough interior of the piston at that end. The final forcible tightening of the six pins takes place simultaneously, the clamp rod and tapered nuts shifting longitudinally until the pressure is evenly distributed.

An equally interesting device is used on a special Gridley automatic turret lathe for making the eccentric piston rings. These are made in gangs of eight from a single casting, held in the chuck of the machine. The inside is bored true, and the outside is simultaneously turned eccentric by a tool mounted on a cross slide, which is moved in and out by a cam rotating in unison with the spindle. A bank of cutting-off tools then comes up, in which each succeeding blade is set a little behind the one that went before it. Thus, when the first ring

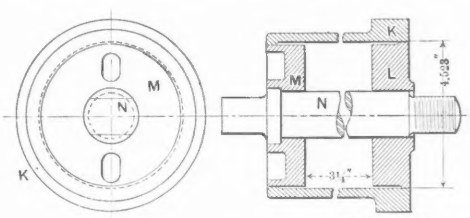


Fig. 7. A Neat Method of Grinding the Outside Diameter of Piston Rings.

has been cut off, the second ring is nearly severed, the third ring is well along, the fourth has been started, etc. The rings drop off in rapid succession one after the other, without waiting for the entire completion of the preceding cut.

In grinding the outside diameter of the piston rings, always a somewhat questionable operation, a method is followed which the writer does not remember ever to have seen used or described elsewhere, although it may not be new to some of our readers. The piston rings, which have by this time been split, and ground on a Heald grinder to accurate thickness, are now sprung one by one into the shell K of the fix-

ture shown in Fig. 7. This fixture is larger in diameter than the piston by the amount which is to be removed from the rings in the final grinding operation, so that these pieces are sprung by the same amount which they will be when in place and at work. When the shell has been filled, the arbor N and the rear flange M are inserted from the back, and the outer flange L is inserted from the front. The rings are then tightly clamped between these two flanges by a nut at the threaded end. The whole is then pushed out of the shell and taken to the grinding machine, where it is finished to the exact diameter of the cylinder bore. It is claimed that this arrangement gives rings which fit as well as could possibly be desired in the carefully-ground cylinders in which they are used.

Many other evidences of careful planning besides those

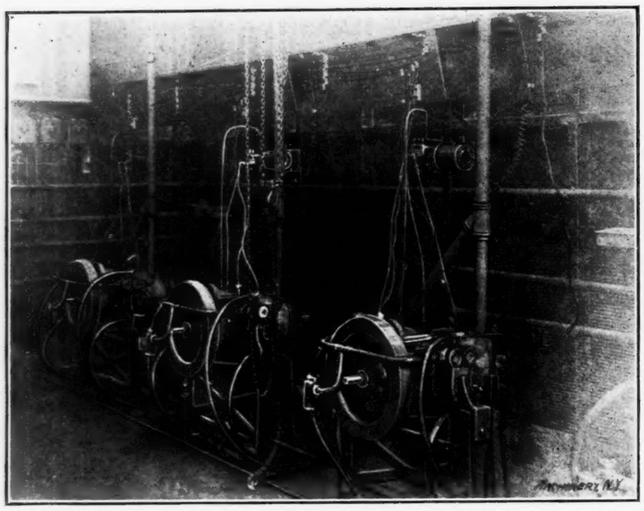


Fig. 8. A Corner of the Testing Room.

mentioned were noticed by the visitor. In the assembling department, for instance, special stands are provided in which the engines are put together. These may be adjusted to various positions to suit the part of the engine being worked on. Here the work of putting together a lot is done on the rotation plan; a workman in carefully prearranged order first attaches one part to each of the machines in the lot, then a second part, then a third—and so on. Certain men thus become skilled in the putting together of certain portions of machines, while the work progresses more rapidly than would be the case if the workmen stuck to one engine until he had it finished. Fig. 8 is taken in the testing room. It is difficult to get a good picture here owing to the dark location of the room and the amount of smoke present in the air. A row of four engines are here under test, the fourth one being just out of sight in the right foreground. There are four similar rows, giving room for 16 machines in all at one time. The building itself is of steel and corrugated iron. Special testing stands were designed for holding the engines. Neat arrangements for piping for gasoline, cooling water, and exhaust are provided, as well as for the ignition wiring and lubrication. Hoists are arranged for setting and removing the engines. All the machines are run here several hours before being finally passed, and the room is a very busy place when there are 16 engines running at from 1,500 to 2,000 revolutions per minute.

Perhaps what is said here in regard to the work at the Providence Engineering Works will still further emphasize the idea expressed in an editorial in the last issue of the Engineering Edition; namely, that sometimes it pays to give a great deal of thought and time and money to the matter of deciding just what you want to do before you commence doing it, even when the pressure for "showing results immediately" is very strong. Of course, with all this planning, some changes were found advisable in the method of manufacturing; besides the proportion of time spent in supervision and other "non-productive" labor may seem large; but the visitor cannot, nevertheless, escape the conclusion that the manager and men of this firm have done wonders in striking boldly out in a new line of work with only limited time at their disposal.

THE DISCIPLINE OF DEMOSTHENES McGINNIS.

THE HIRED MAN.

Demosthenes McGinnis was principal owner, and manager of the machine shop in Helvertown. The shop was on the bank of "the river" which was about 6 inches deep in some places, and less in all other places, which fact did not prevent Demosthenes from printing on his letter heads and catalogues a cut of the "Works" and the river with a palatial steamboat, the "City of Helvertown," sailing majestically down it.

Julius Cæsar McGinnis, the son, was a 'prentice boy in the "Works"; so was I, and so was Shadegg Slate and lots of others not necessary to mention. All the kids around the place had nicknames. Julius Cæsar's was "Slobby"; Shadegg was known as "Rye-Balls, High-Balls, Ricky-Stick Slate," when there was plenty of time, and simply as "Ricky" when time was valuable; mine was "Big-Head-Mulligan," which I mention only to show that the names usually went by contraries, as everybody knows I am extremely modest.

It is hardly necessary to explain that Demosthenes himself was known as "The Old Man."

Ricky's peculiarity was that he *always* had to make more than one piece of everything; that is, he always spoiled the first piece and usually the second and third; thus, one day the kids collected *four* small pieces that Ricky had spoiled while trying to make *one*, and put them in his dinner pail just before quitting time. Nobody ever knew just when and where Ricky discovered the contents of his pail, but they observed the next day, when he spoiled three larger pieces, that instead of putting them under the bench where the kids could get at them, he chucked them out of the window into the river, but on account of the peculiarity of the river first mentioned the spoiled pieces were plainly visible, and the next day *the foreman brought a pair of rubber boots.*

The Discipline of Demosthenes McGinnis.

The reader will gather from the above that Ricky's mind was likely to be on something else than "learning the trade" most of the time, and of course the something else was usually playing tricks on the other 'prentice boys (and journeymen too, for that matter). So one day he looked out of the window, presumably to see if the steamboat had got by yet, and discovered "Slobby" McGinnis fishing out of the window below, although there was as much chance of Ricky finding the steamboat, as of Slobby finding a fish in *that* river; and it didn't take Ricky very long to find a bucket of dirty water, and pour it down on Slobby's head.

Slobby made a bee-line for the office and told his father what had happened to him, and the old man came out, located the window, went upstairs, and over beside Ricky, who, when he saw the old man, considered that his last hour was come, on account of this and all his former shortcomings.

"Are you the boy that threw the water on Julius?"

"Y-y-yessir," stammered Ricky, knowing denial to be useless.

The old man reached down into his pocket, pulled out a coin, and laid it down on Ricky's lathe and said: "Here's a half dollar for throwing another bucketful of water on him next time you catch him fishing out of the window."

Which goes to show, in my opinion, that the old man had more horse sense than some of his enemies gave him credit for.

HURD & HAGGIN MARINE AND RAILWAY ENGINE.

A new marine and railway gas engine was exhibited at the Motor Boat Show (held in Madison Square Garden the last of February) which attracted much attention on account of its novelty of construction and ingenious features of design. The new engine was designed by Mr. Leon le Pontois, in collaboration with Mr. B. Hurd, and is built by the Hurd & Haggin Engine Co., 316 Hudson Street, New York.

The engine, shown in the accompanying halftone and three line drawings is of the vertical six-cylinder type (38 H.P. at 750 R.P.M.) and is designed for both marine and railway service, the designers having in mind, so far as railway service is concerned, the development of the railway motor car which promises to be an important factor in future steam railway passenger service. The impression made by the engine is that an extraordinary amount of care and thought has been devoted to its design. The compactness, convenience, accessibility and ingenuity of the design are noticeable in every part. In an analysis of the problem of a gasoline engine design of the four-cycle type the engineers have considered that there are five fundamental constituent elements that should be provided for, these being the mechanical construction of the cylinder including the form of the combustion chamber; the location of the valves with relation to the combustion chamber and their mode of operation; the means devised for producing the combustible mixture, and for delivering it uniformly to the cylinders; the means provided for causing the ignition of the explosive mixture at the proper time; the water circulation; and the lubricating system.

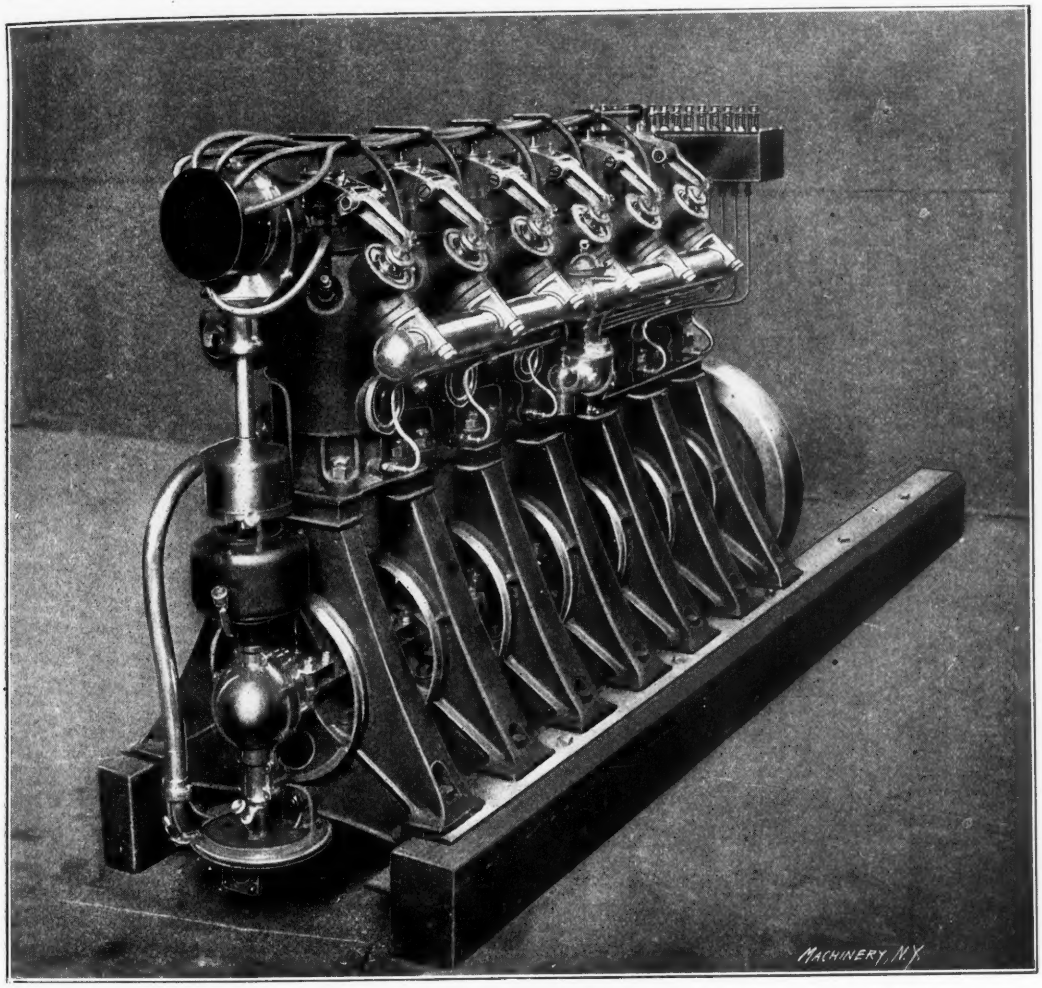


Fig. 1. Hurd & Haggin Marine and Railway Engine.

Mechanical Construction.

The valves, piston and piston ring, connecting-rod, bearings and main bearings of the crankshaft, which are the working parts that need most attention, are made readily accessible. The valves, for example, are located in the top of the combustion chamber at an angle of about 45 degrees which permits of a hemispherical shape to the combustion chamber and gives a minimum of radiating surface for a maximum volume of gases. The valve, the valve seat and spring, are self-contained in a cage which is removed from the cylinder head by unscrewing a locking ring and removing the corresponding rocker arm operating the valve. The removal of the valve cage permits full inspection of the inner walls of the cylinder and combustion chamber. Should there be any carbon deposit resulting from improper lubrication it may be easily removed inasmuch as the inner walls of the cylinder and combustion chamber are machined all over. The inlet and exhaust valves, with their cages, are made interchangeable. The valves are mechanically operated by means of rocker arms oscillated by cams mounted on a camshaft. This camshaft is located on top of the cylinders and is entirely enclosed and runs in a bath of oil. It is operated by a bevel gear drive from the crankshaft through a vertical shaft located on the front end of the engine. This vertical shaft also serves for the sparking apparatus which will be described hereafter. Both pairs of bevel gears are enclosed and run in oil, thus protecting them from grit and excessive wear.

Not the least of the novel features of design is the support for the crankshaft bearing. The struts or columns supporting the cylinders are bored interchangeably and in the openings are seated the bearing brackets. This feature not only provides an ideal means for lining and setting the bearings dead true, but makes the removal of any piston, crankshaft bearing or the crankshaft itself a comparatively simple and easy matter. To remove a piston it is only necessary to detach the crankshaft oil guard, remove the connecting-rod cap, raise the connecting-rod off the crankpin and then withdraw the connecting-rod and piston from the cylinder and out between the struts. Thus the piston and its rings may be examined readily. The reverse operations of restoring the piston to its cylinder are equally as easily effected. The bushings, lined with Fahrig metal, for the crankpin and for the main bearings are also readily removed, and as they are interchangeable, worn bushings may readily be replaced when necessary. By removing all the pistons and the connecting-rods in the manner just described and by removing the main bearing caps the crankshaft may be withdrawn through the circular holes in the columns without disturbing the remainder of the engine. This construction is not found in any other engine.

Fuel Production and Distribution.

The carbureter produces a mixture having a uniform composition under all conditions of throttling. This is effected positively without resorting to the use of auxiliary automatic air valves, by a simple mechanism in which the relative effective areas of the throttle valve and air inlet opening are kept constant. The combustible mixture is distributed to the cylinders by means of diverging nozzles in the manifold so designed that the composition of the mixture entering each cylin-

der is homogeneous regardless of the distance of the cylinder from the source of fuel supply. This construction does away with ungainly shaped manifold pipes ordinarily employed on multiple cylinder gas engines.

Ignition.

Ignition is produced by means of a high tension alternating current generator and a step-up transformer. The primary current is generated in a positively driven alternator, the rotor of which is mounted on the vertical bevel gear shaft. always have the necessary priming. The stream of water issuing from the pump is directed to each cylinder jacket by a manifold. The size of the inlet openings leading from the water manifold to the respective cylinders has been experimentally determined so as to insure an even distribution of water among the cylinders. The cooling water enters the bottom of the water jacket on the exhaust side of the cylinder and leaves it on the same side above the exhaust valve at the top of the cylinder. This circulatory scheme insures proper cooling of the exhaust valve seat. The cooling of the

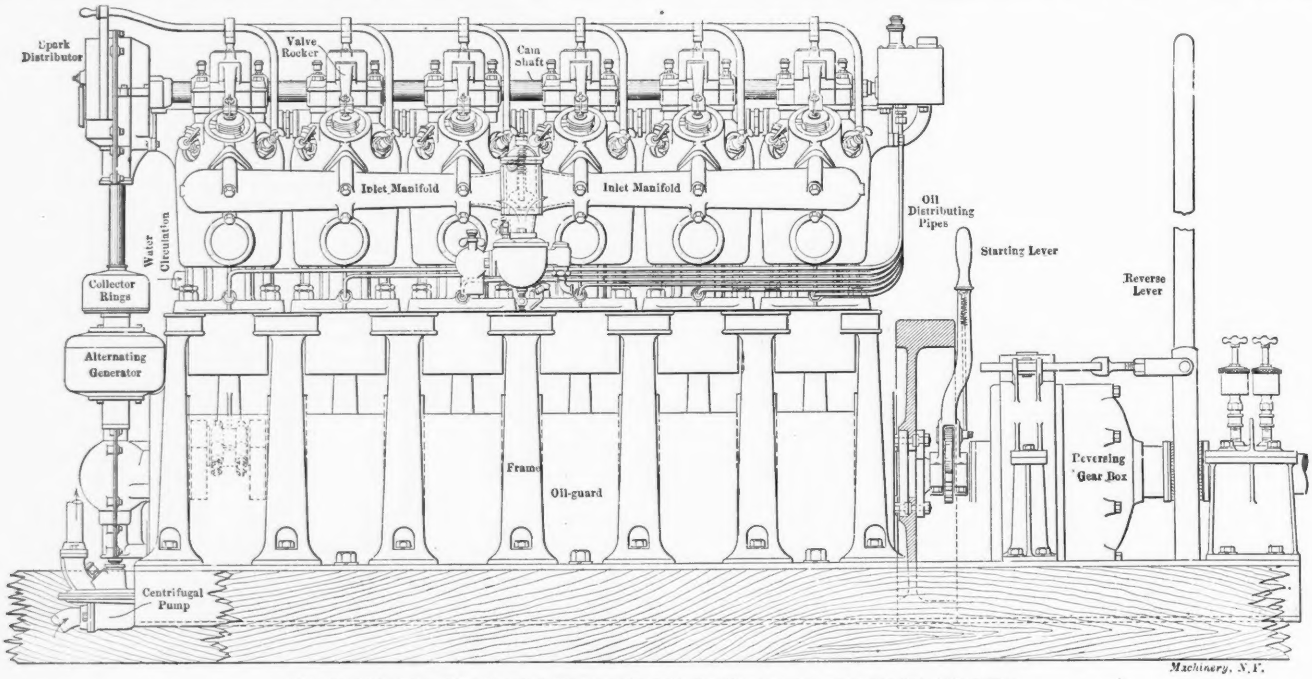


Fig. 2. Side Elevation Hurd & Haggin Six-cylinder Engine, showing the Inlet Manifold.

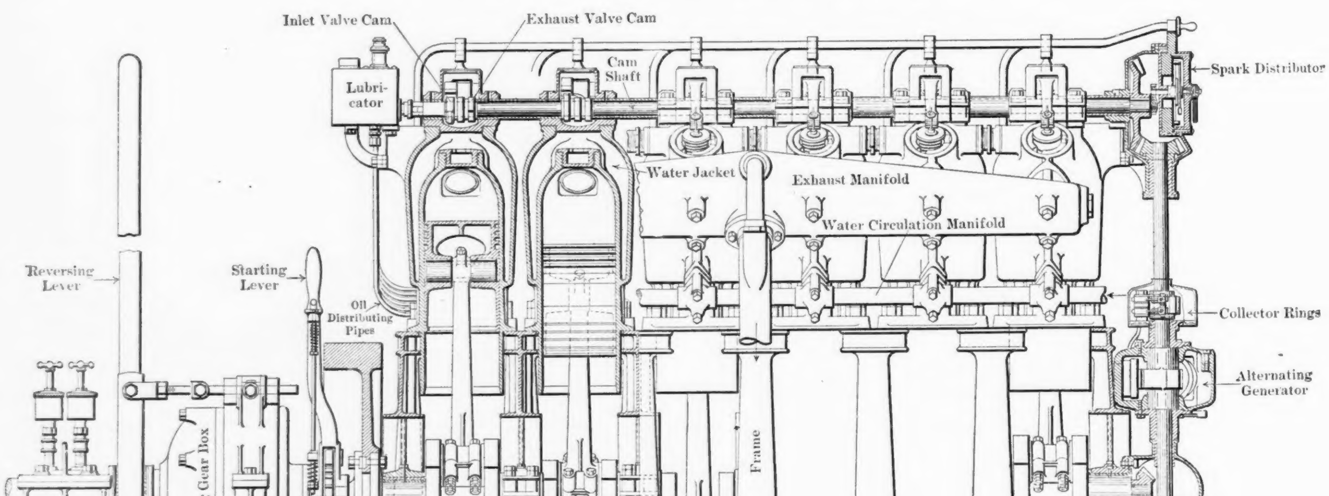


Fig. 3. Side Elevation of Hurd & Haggin Six-cylinder Engine, showing the Exhaust Manifold and Section of Cylinders.

This generator belongs to the inductor type, the rotating element carrying no windings of any kind. The high tension current from the transformer is delivered to the spark plugs of the cylinder by means of a high tension distributor mounted at the top of the bevel gear shaft.

Water Cooling.

An important feature of the design is the adequate means provided for uniformly cooling the cylinder walls and valve chambers. The cooling water is circulated by means of a centrifugal screw pump mounted directly on the lower end of the vertical bevel gear shaft, below the water level, so as to inlet valve seat and of the inlet side of the cylinder is effected by thermo-syphonic action. The water issuing from the upper part of the cylinder jacket, enters the water jacket of the exhaust manifold, circulates around it, and leaves it on the opposite side by an opening at the highest point of the exhaust manifold. This location permits any steam that may be generated, to escape with the water.

Lubrication.

A mechanically-operated multiple forced-feed lubricator is directly driven by the camshaft. Each crankshaft main bearing is connected to the lubricator by a feed pipe, and the ex-

cess oil fed to each bearing works into a grooved oil-ring from which it is guided by centrifugal force into the crankpin bearing. Each cylinder is also connected to the lubricator by an individual feed pipe; the excess oil fed to the cylinder enters the hollow wrist-pin, finding its way to the crankpin bearing through a hole in the connecting-rod. The oil drippings from the bearings are collected in the crankshaft oil guards and are directed by suitable piping to a cistern where the oil is filtered and piped back to the lubricator to be used over again.

These engines are to be built in three cylinder sizes, *viz.*, 4¾ x 5½ inches; 6¾ x 7 inches; 9¾ x 8½ inches, in four-cylinder and six-cylinder units. The rating of the engines is determined by the piston speed in feet per minute, 750 feet per minute being taken as the standard speed. At this speed the power of the 6-cylinder engine illustrated, is 38 H. P.; for 6¾ x 7 inches cylinders 77 H.P.; and for 9¾ x 8½ cylinder 160 H.P. One of the features of design of obvious common sense, but which unfortunately has not been followed in many designs of marine engines, is that the flywheel is placed between the engine and the load where it belongs, thus relieving the crankshaft of unnecessary stresses.

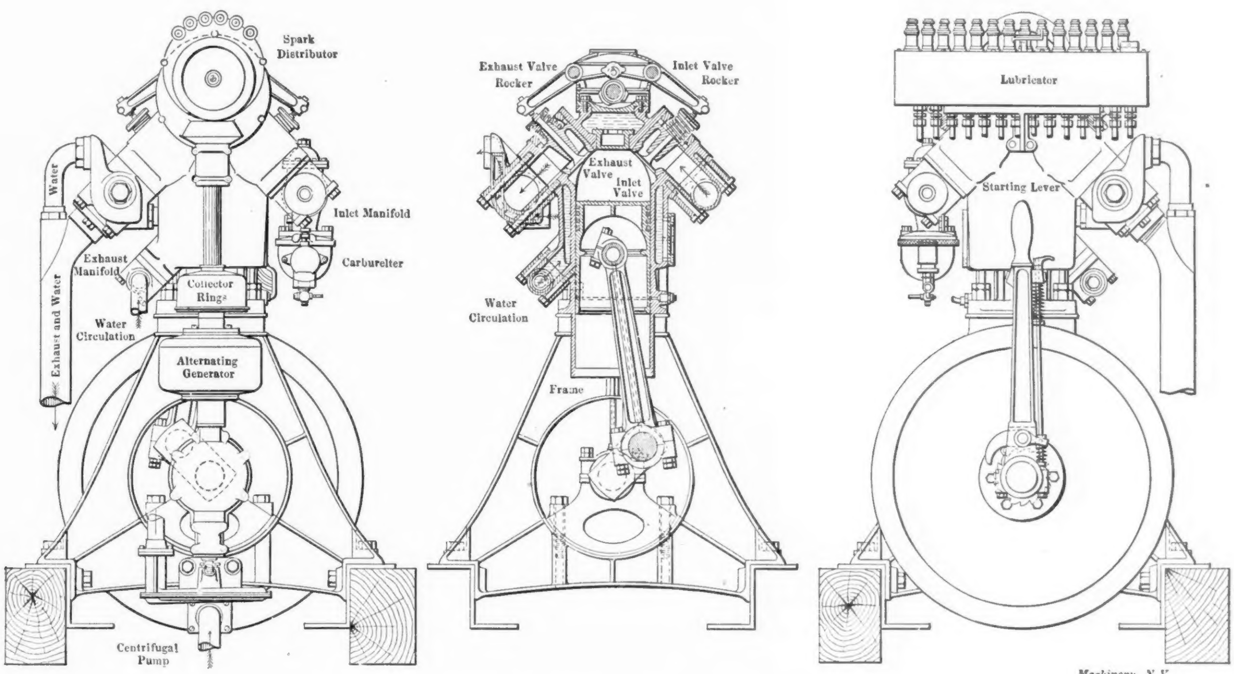


Fig. 4. End Elevations and Section of Hurd & Haggin Six-cylinder Engine

* * *

FAILURE OF WIRE ROPE CONNECTIONS.

The failure of the antenna of the National Signalling Co.'s station at Machihanish, New Brunswick, furnished material for three pages of the January 25, 1907, issue of *Engineering* (London), and so far as is apparent from the description and cuts the failure was due to following a practice in connecting wire rope that was discarded years ago in this country by reputable elevator constructors and others as being unreliable and dangerous. The antenna that failed was 400 feet high and essentially consisted of a steel pipe tower supported by guy ropes attached to the tower at four points in its height and diverging in four directions. The failure was caused by the guy ropes pulling out of their sockets. They were connected in the manner just mentioned as being obsolete and dangerous, that is, by feazing the end of the cable and turning the wire ends outwardly backward on themselves and drawing the feazed end down into the socket, which was then filled with melted zinc. The safe method for connecting wire rope to a socket is quite different. The ends of the wires are untwisted and opened outward and are then turned inwardly backward upon themselves so that the ends of the wires are grouped together in the center, the socket being filled with melted zinc or lead as above. The action of a wire rope and socket connected in this manner is radically different from those connected in the manner followed by the wireless telegraph erectors. In the case where the wires are turned outward there is a continual tendency to slip the ends of the wire backward, as a heavy load is imposed, and there may be a slow creep, eventually causing failure. Where the wires are turned inward there is no tendency for the bent wires to creep, and the enlarged end of the cable wedges tightly in the socket. Although the *Engineer* gives so much space to the failure, showing numbers of photographs of the failed ends, not a word is said of the fundamental cause of the failure.

* * *

THE DIRECTION OF SHOP OPERATIONS.

A correspondent writes: "Much of a foreman's time is taken up in answering foolish and thoughtless questions"—and it is true. The writer then follows with a scolding and asks why, instead of chasing up the foreman and consuming his time by asking some simple or foolish question, they do not use their own "thinkers" and figure out the reason why. It is common in *some* shops for a man to rush off to a foreman the moment he finds the least something that he does not understand. Meanwhile his machine is standing idle, and he loses time in questioning the foreman to get the required information.

No doubt there is a great deal of this foolishness going on, but instead of blaming the workmen alone, may it not be that the foreman is in a large measure responsible for this condition of affairs? Some foremen are so afraid that their prestige will suffer if the men are allowed to exercise initiative and largely go ahead on their own account that they will make a point of finding fault with work that is done without their approval; hence the men soon learn that they must get the foreman's O.K. on any matter over which there might be a difference of opinion. The foreman wishes himself to be felt indispensable and of so much importance that nothing can be done without his direct supervision. In this he makes a bad mistake. He not only loads upon himself an unnecessary burden of responsibility, but weakens his effectiveness as a foreman and tends to make his shop a poorly organized one. The well-organized shop, it has been aptly said, is that which the official head can leave to its own devices for a few days and still feel assured things will run along as smoothly as though he were present. The foreman who is not able to plan ahead and give some workmen directions so that they may be left largely alone for a day or so is wearing himself out in a thankless service.

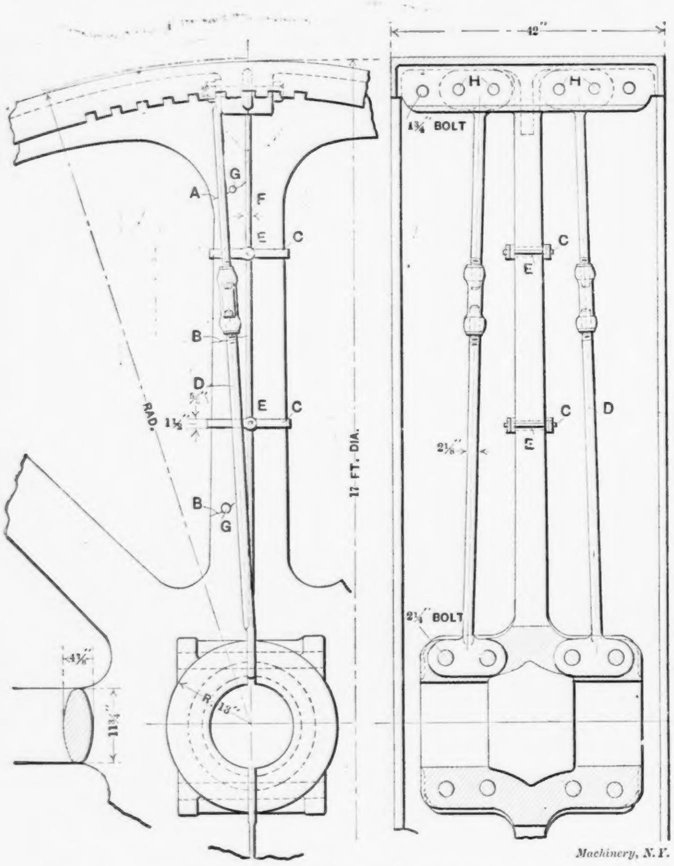
REPAIRING A 17-FOOT FLYWHEEL ARM.

WALTER BIXBY.

While moving one of the halves of a 17-foot flywheel, an arm was cracked at *A* (see cut). A consulting engineer suggested that the best method to repair the break would be to braze the parts together. This plan was tried and proved successful, with the exception, that the rim was distorted about ½ inch, as shown by dot and dash line. In trying to remedy this latter defect, the arm was cracked at *B B*.

The break was finally repaired in this manner: Two wrought iron rods were made 2⅛ inches diameter, as shown at *D*, and two pairs of semi-rings shown at *C*. First, the rings *C* were heated and placed in position and the pins *E* driven in place, the pins being slightly larger than the space *F*. When the rings cooled off, they held the arm firmly in place. The pins *G* were then forced in position to help sustain the arm. The rods *D* were put in place and by means of the turnbuckles, the rim was drawn back to its right position.

We will now see if this manner of mending the arm is strong enough to resist the forces acting on same. The arms



Repairing a 17-foot Flywheel Arm.

have to resist in tension the centrifugal force, and the stresses at the hub due to the bending action considering each arm as a cantilever.

The tensional strength of wrought iron is about three times that of cast iron of the same area. Assume that the areas of the arms are strong enough to resist the centrifugal forces. One half the area of the arm section, considering this an ellipse, is equal to $\frac{\pi \times 11\frac{3}{4} \times 4\frac{7}{8}}{8} = 22.5$ square inches (approximately).

If the sum of the areas of rods is 1/3 that of the arm, the rods resist tension with equal safety as the arm. $1/3 \times 22.5 = 7.5$. Hence the area of one rod ought to be about 3.75 square inches. We used rods 2⅛ inches diameter; their area is 3.55 square inches, which may be considered sufficient.

In calculating the bending action let

M_b = bending moment for one arm,
R = radius of hub = 13 inches,
R_a = radius of flywheel = 102 inches,
A = number of arms = 7,
I = moment of inertia of arm section,
N = number of revolutions per minute = 70,
$H.P.$ = horsepower of engine = 400.

$$\text{Then } M_b = \frac{33{,}000 \times \text{H.P.} \times 12\,(R_a - R)}{2\pi \times R_a \times N \times A}$$

or with values inserted

$$M_b = \frac{33{,}000 \times 400 \times 12\,(102 - 13)}{2\pi \times 102 \times 70 \times 7} = 45{,}000 \text{ (approximately).}$$

$$I = \frac{\pi \times (11\frac{3}{4})^3 \times 4\frac{7}{8}}{64} = 385 \text{ (approximately).}$$

If y equals one-half the width of the arm, then the working fiber stress

$$f = \frac{M_b \times y}{I} = \frac{45{,}000 \times 11\frac{3}{4}}{385 \times 2} = 700 \text{ (nearly)}$$

There is also a shearing action on the bolts *H*, due to the centrifugal force. Assuming the working tensile strength of wrought iron 7,000 pounds per square inch, a rod 2⅛ inches diameter will stand a load of 18,600 pounds. Assuming this load to be applied on bolts *H* in shearing, on one bolt there will be a load of 9,300 pounds. The working shearing strength of wrought iron is 5,000 pounds per square inch, hence, a 1¾-inch bolt will stand 8,750 pounds, nearly the assumed load on one bolt. The factors of safety have been taken high in the above working stresses, because the flywheel is in a paper mill which runs day and night throughout the week.

Another thing to be considered is the effect of the increased weight added to the flywheel acting as a counterweight. It was thought at first that it might affect the engine, but it came exactly opposite the crank pin. The flywheel has been running for three years, and up to the present there has been no trouble experienced or any signs whatever of its giving out.

* * *

THREADING PIPE WITH COLD CHISELS.

Some twenty-five years ago the piping went wrong at an important water station of one of the railroads entering Chicago. The superintendent of the water service, who is responsible for the following account of the incident, got together such men and tools as he could and hurried to the scene. Arriving at the station, he found the four-inch wrought-iron pipe broken squarely off, only two feet of water in the tank, and no means of getting a piece of pipe from any shop, cut to length and threaded, inside of twenty-four hours. Unwilling to interrupt the water supply and determined not to acknowledge defeat until the last resource was tried, he cut a piece of pipe to length with cold-chisels, chalked the unthreaded end, placing it in line, end to end with a threaded old piece of the same size pipe, and with a two-pointed tram, one point engaging the thread of the old pipe, the other scribing on the chalked end of the blank pipe, he followed the thread with one point, always keeping the tram parallel with the axis of the pipe. The path of the right-pitch thread was thus scribed by the tram point on the chalked surface of the blank end of pipe requiring thread. The spiral scribe mark made by the tram was nicked with chisels, deepened and made continuous, until at the end of an hour and a half a good thread was cut, the job put up without a drop of leakage and without interruption of the water service.—*Valve World.*

[This sounds well—but what became of the surplus metal that ordinarily is cut away by the pipe die? The "cold-chisel thread" must have been of greater diameter than the pipe itself unless the pipe were filed away considerably before the thread was "chiseled."—EDITOR.]

* * *

By their overalls ye shall know them.

For the broken teeth of a tap there is no dentist.

The broken-backed monkeywrench had a fool for a user.

A round peg in a square hole—lard oil on the spindle.

Choose your foreman as you would a hammer—weight appropriate to the job.

The common sucker is born, but the shop kind is made by encouragement.

RECENT CHANGES IN MACHINE SHOP, WORCESTER POLYTECHNIC INSTITUTE.

H. P. FAIRFIELD.

The substitution of electric transmission for all departments of the Worcester Polytechnic Institute, upon the installation of the new service plant, gave opportunity for the rearrangement of the equipment in our machine shop, and it is possible that some of the readers may be interested in a few photographs showing the present driving arrangement.

Because of the first cost and necessity of making use of the original machines, no attempt has been made to install individual motors, group driving being used instead. When the use of individual motors was under consideration, the builders of machine tools consulted, and the users as well, were unanimous in condemning the use of individual motors under 2 H.P.

In considering the group-drive plan, the character of the work done in our shops was taken into account, and as this is what may be termed "light machine tool work," the groups

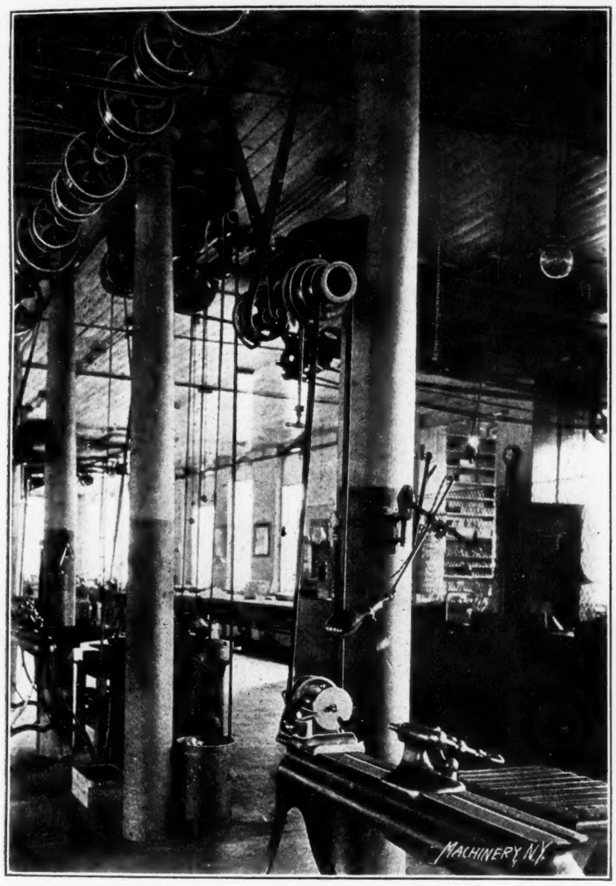


Fig. 1. Speed Lathes Located directly beneath Lineshaft.

have been made in *number* and *size* of machines, and the motor is therefore of relatively small power. Two sizes of groups obtain. The motors driving them, rated as 5 H.P. and 10 H.P., are of the two-phase A. C. type, very compact and easily installed. The major part of the groups is driven by 5-H.P. motors, and in most cases the present installation of these merely meant, first, a decision upon their location; second, the size of group to drive, and the cutting of former line-shafting into sections to suit. All groups as now arranged are really double groups, planned with sufficient vacant floor space to permit additions of equipment. When any motor becomes overloaded by new acquisitions of machinery, a second motor will be installed, and two groups made of what was formerly one. In this manner, instead of growing new groups as the equipment is increased, there is an opportunity given to keep each group up to date by additions of new and strictly modern machinery. The vacant floor space necessary to carry out this idea is gained by a more compact and scientific arrangement of the former equipment. One instance of this utilization of floor space is shown in Fig. 1, where the speed lathes are placed directly under the line shafting. An engine

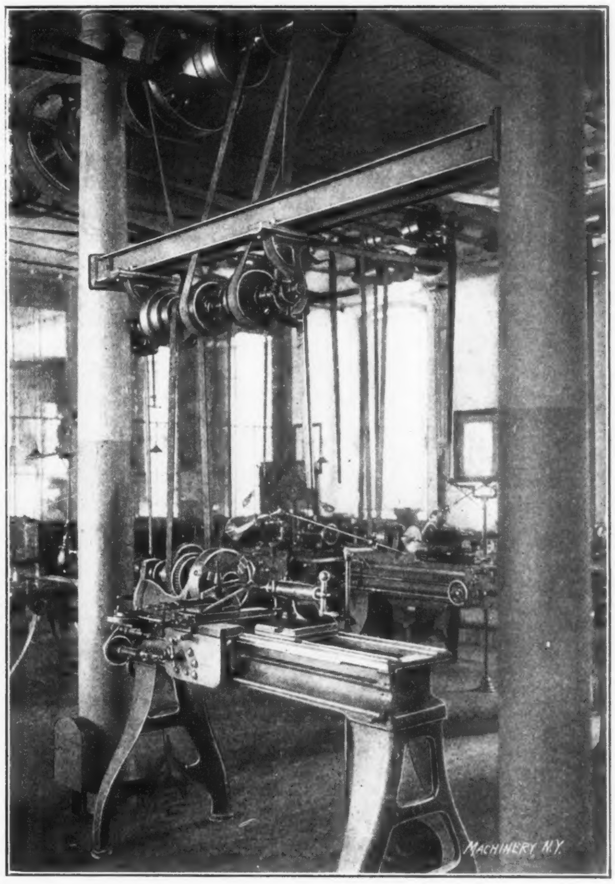


Fig. 2. Engine Lathe beneath Lineshaft and driven by Short Belt from Countershaft.

lathe is also arranged, by way of experiment, beneath the line shafting, as shown in Fig. 2, and the shortening of the vertical driving belt does not appear to lessen its pulling power appreciably. The motors being hung from the ceiling, as shown in Fig. 3, a good opportunity was given to place them so that a

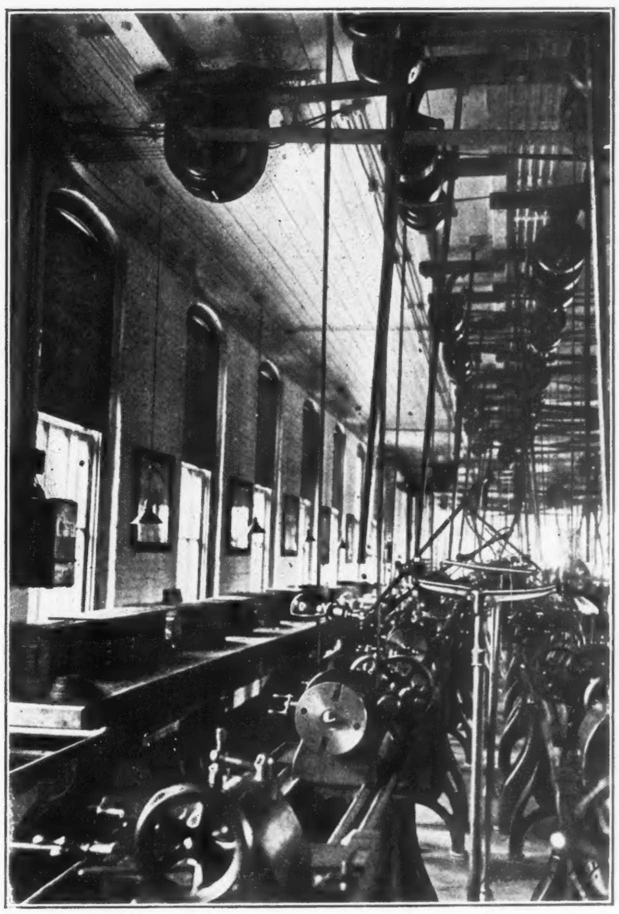


Fig. 3. General View of one Section showing Motor, System of Electric Lighting, Etc.

proper length of belt could be obtained, and also to have the lower side of the belt drive. The motor that drives group No. 5, which is a planer group, has an especially long belt to equalize shock due to reversal of the pulleys on the machines.

The groups are divided into three sorts: lathe groups, mixed groups, and planer groups. The mixed group is the most common, and consists in every case of several lathes, and beside this, one or more machines of an essentially different character. Group No. 2, for example, consists of six 14-inch engine lathes, two 9-inch speed lathes, small drill press, 15-inch shaper, universal milling machine, 24-inch planer, and a globe tool grinder. Group No. 5 consists of a 30-inch by 10-foot and a 36-inch by 14-foot planer. No. 2 and No. 5 thus represent the extremes in the present grouping scheme. The question of lighting the several machines was solved, as shown in the views, particularly Figs. 3 and 4, by putting the wires beneath the floor, and thus avoiding the tangle of belts, wires, and overhead fixtures present in many shops. The convenience with which these lights may be handled is such that it is in general favor with those using the machines. An increase in the speed of the line shafting from 150 R.P.M. to about 200 R.P.M. was also made to meet the demands at the machines due to the use of the high-speed steels.

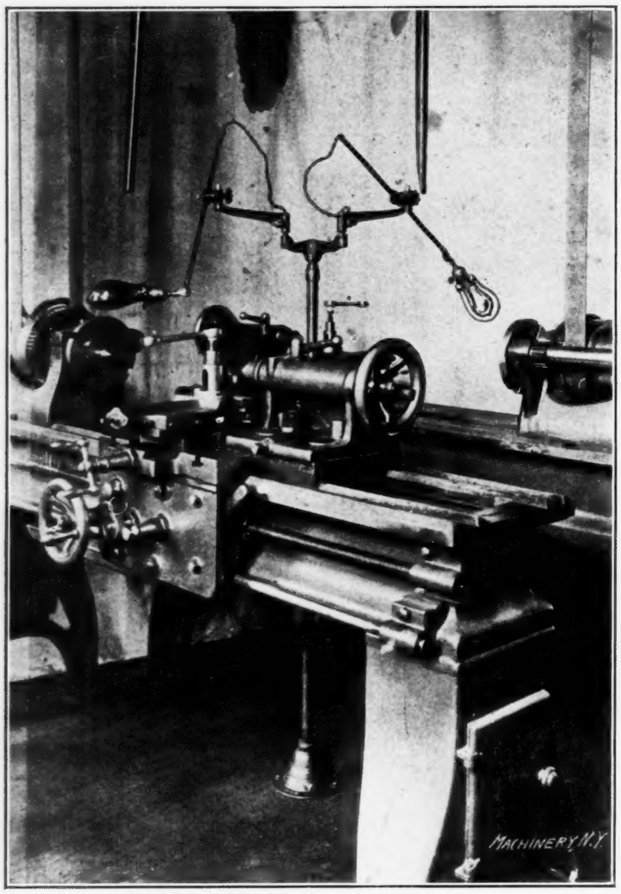


Fig. 4. Engine Lathe with Electric Light Holder in Rear.

Enlarged photographs of machines, suitably framed to hang upon our shop walls, were solicited from about twenty-five representative firms, and in only one instance did we fail to receive a favorable reply. Many of these pictures have already been received and hung, Fig. 3 showing a small portion of the total number. The effect is pleasing and valuable, as it shows what is being done in machinery designing.

A demonstration room is also being slowly equipped with the latest time and cost-keeping devices, such as time clocks, time stamps, and methods of keeping track of stock. Beside this, many special tools are placed on exhibition. As this entire equipment is to be in the nature of a loan or gift, it, like the pictures, must come by solicitation.

Additions of new machine tools are being made from time to time and in every way possible the shop is to be kept up to date. The students are thus able to know something of the conditions under which the manufacturing manager exists, although no attempt is made to make the shop a factory.

SOME GOOD THINGS NOT IN COMMON USE.

E. R. PLAISTED.

I do not want to be accused of re-writing ancient history, but what else is to be done when those fellows continue to bob up with new recipes for fluid to write white on blueprints? To my personal knowledge there have been on the market for nearly twenty years several preparations that are perfectly satisfactory for this purpose, and as much to be preferred to any of the home-made dopes of saleratus or lime as Higgins' or Post's inks are preferable to the sort we used to grind off the end of a stick in the "good old times."

The kind I use is called "crystalline" ink; it writes as clear white as the paper itself, never discolors with age, nor does it rot the paper. I have never been able to detect traces of corrosion on the pens in consequence of using it, though I handle it with the care I would give to any such preparation whose composition I am ignorant of. These fluids are a colorless acid, and some bear the poison label of skull and crossbones, though the kind I use does not. They can be had in colors as well as in the clear white, and sell for 15 cents a bottle at all dealers in draftsman's supplies. Quite too cheap to do without.

I believe at one time someone wrote a short article telling what the name of this acid is, but I cannot recall it, and the local druggists do not seem to be able to duplicate it from their stock. But as it is put up in such convenient form by the supply houses and sold at such a low price I do not see how any draftsman who knows of it can afford to worry along with solutions of lime, soda, ammonia, chinese white, etc., etc.

Another good thing that the dealers do *not* sell is the cross section paper made by the J. C. Hall Company, Providence, R. I. I found the Brown & Sharpe drafting force using large quantities of it, and they gave me the address of the makers. My own experience has only confirmed the good opinion their high endorsement of it gave me.

It comes in sheets 18 x 25 inches, ruled in eighths, with a blank white margin of some ¾ inch around the edges. The lines at halves and inches are a trifle heavier than the eighths, and it can be had in tenths also if one desires that spacing. Also it is supplied in two grades of stock, one a fine bond and the other a smoother and cheaper paper, though amply good enough for all common shop work. Both yield a fair blueprint direct from the drawing.

The Hall Company also put out two sizes of pads of cross section paper, one 5 x 7 ruled in sixteenths to 4 x 6, the other 7 x 9 with same ruling and width of margin. I find both very handy, and also keep a good stock of the common cross section paper ruled all over in quarter inches. This I have in pads of two sizes, one being "typewriter" size for use in making sketches that are to be copied in letter books, and sent with letters. The smaller size is very handy for general rough sketching and figuring, and so cheap that I do not keep any other sketch pads in the drafting room. I once read a kick from a fellow who didn't think cross section paper was any good for laying out gear teeth on, and I presume he was right about it, but for such work as it is adapted to, and that is the large majority of sketching jobs, it is a great saving of time. For rushing a hurry job into the shop I do not know of anything to compare with it.

I fully endorse that item about keeping a piece of blotting paper hanging handy to the drafting table, and a patent spring clothes-pin makes a good holder for it, as it can be snatched in an instant when the moment of need arrives. This is sure to come sooner or later, and no matter how many pieces are lying around loose none ever happens to be within reach just then.

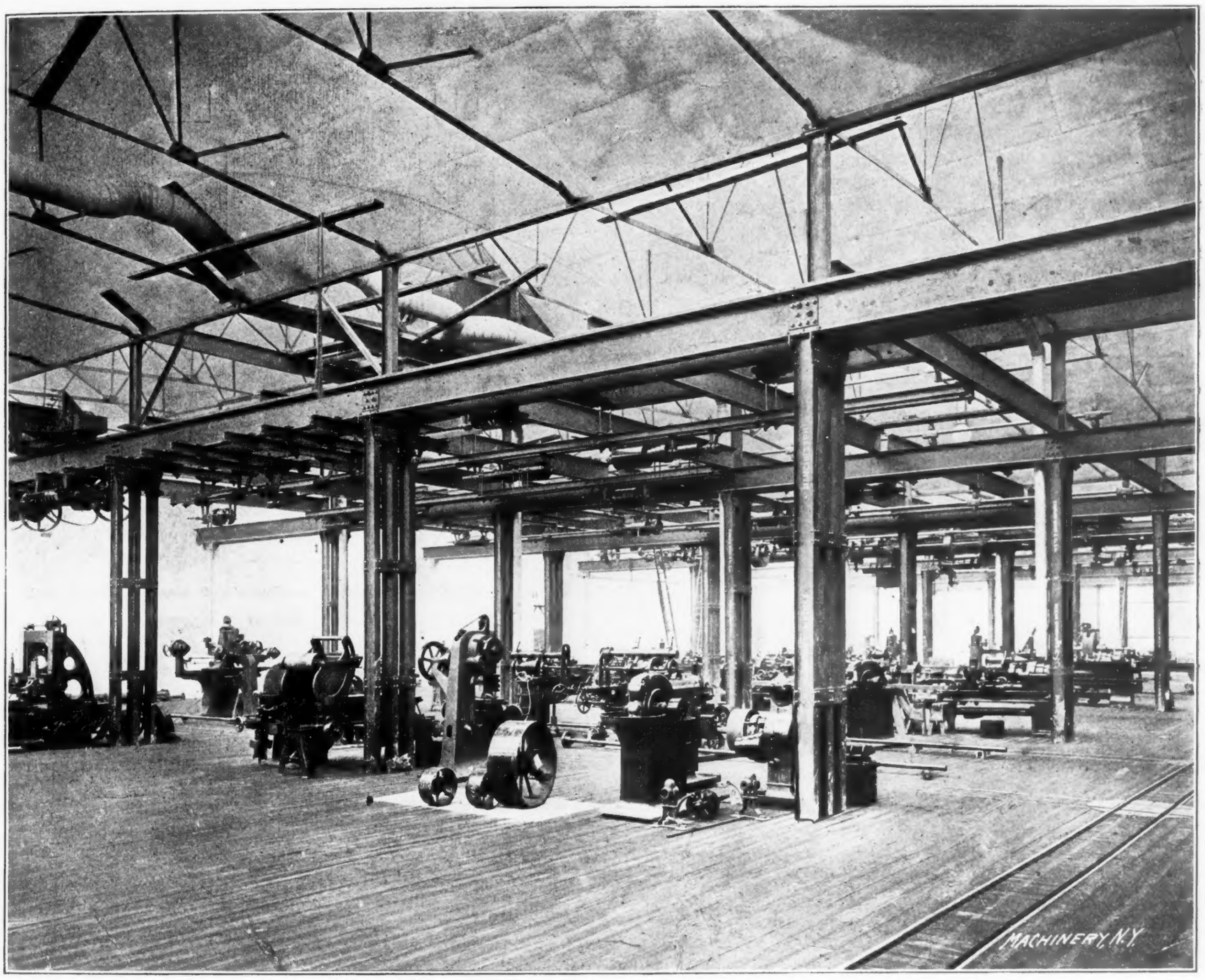
Still another good thing that I have not been able to find in catalogues of draftsmen's supplies is a "pick-ed" stick for writing and lettering on shop drawings. So primitive an affair may not seem worth carrying in stock, but there are sticks and sticks, and even back here in the woods I had considerable difficulty in getting just what I wanted. It is made from boxwood, whittled and sandpapered to a sharp point, four sided, and though it does not hold its point like a metallic tool it is better than anything else I ever tried for lettering and dimensioning on common shop drawings. When I first

began drafting I put in my dimensions with common steel pens, some of which were sold as "lettering pens" but were actually no better than the common kind. All gave a shaded line, and to my mind this is a nuisance on a working drawing. Then I tried the stylo and the glass pens used for marking linen. These gave lines of even width and weight but were unsatisfactory in other ways. Finally I tried a "wedge screw" ruling pen which I re-ground in such a way that the blades would not catch and splutter, no matter what angle it might be held at. For fine lettering and dimensioning I have never found anything better, but I still have to grind them myself. Even the best instrument repairers do not get the blades dressed to the required smoothness, for a pen which will work perfectly when used with a ruler may be a total failure at this business. The wedge screw pen is adjusted from the end of the handle and has no screw in the blades to get in the way when writing.

* * *

PHOTOGRAPHING DRAWINGS.

Blueprints made from drawings on a greatly reduced scale are convenient and oftentimes they will serve the purpose precisely as well as the large sheets commonly used. The *Street Railway Journal* calls attention to the desirability of providing small blueprints for field work in preference to large prints which can only be referred to with great inconvenience, especially in windy weather. While the conditions in shop practice are not the same as in field work, it nevertheless is true that a large blueprint is often a troublesome affair to refer to in the shop unless mounted, and if it is not to be used continuously this labor is generally avoided. Oftentimes a blueprint is of so simple a character that there is little good in its being made to a large scale. The large shop print is a relic of the days when all drawings were made without figures and were scaled for all required dimensions. Of course, a drawing must be made to such a scale as will permit the draftsman to correctly and plainly show the details and dimensions, but an inked drawing can be photographed clearly to a greatly reduced size. A negative $6\frac{1}{2}$ x $8\frac{1}{2}$, properly exposed will print drawings with surprising sharpness and clearness on gaslight paper, even though of a complicated design. These might not do for shop work in some cases, but for general reference and over-all dimensions such miniature prints are far preferable to the ungainly drawings commonly sent into the shop. The expense of making photographic reproductions, and the trouble and time required, operate against such practice being followed in the smaller shops, but in larger shops it is a practice to be highly commended and is one that is finding favor.



Interior of New Edgwick Works, Alfred Herbert, Ltd., Coventry, England.

THE EDGWICK WORKS OF ALFRED HERBERT, LIMITED.

The accompanying view showing the interior of the new Edgwick works of Alfred Herbert, Ltd., Coventry, England, was received too late for publication in the March issue in connection with the article there appearing. This view gives a good idea of the excellence of interior lighting, and shows the column construction alluded to in the previous article more clearly than did the view given; it also shows the method of hanging the countershafts. In this connection an error should be corrected in regard to the size of the plant. The present size is 100 x 240 feet, and it was stated in the previous article that the plant provided for extending to 240 x 400 feet, all under one roof. What the plans *do* provide for is an extension to 300 x 400 feet; not only are the bays to be lengthened to 400 feet, but two additional bays are provided for. Consequently the power plant is only one-fifth of its destined ultimate size, instead of one-fourth, as stated.

MEASURING WIDTH OF FLAT ON U. S. STANDARD THREAD TOOLS.

ERIK OBERG.

When making U. S. standard threading tools it is comparatively easy to arrange for gaging the angle, but the measuring of the width of the flat is a more difficult task, if by measuring we understand the process of making sure that the flat is fully correct, and not merely comparing the thread tool we make with a manufactured thread gage, which is a very uncertain test for accurate work. The common method is a "cut and try" scheme, first cutting a thread on a cylindrical piece with the tool supposed to be approximately correct, and afterward using the same thread tool with which this thread was cut to plane a groove in a flat piece of steel. The groove in the flat piece of steel is then a duplicate of the thread previously cut and should also be an exact duplicate of the section $GACF$ of the thread cut on the cylindrical piece (see Fig. 1). When testing, if the groove proves to be an exact duplicate of the thread form, the flat evidently is correct, inasmuch as the flat at the bottom and at the top of the thread are alike, it being supposed that the angle was previously tested and found correct. However, if the groove in the flat steel piece does not exactly fit the section of the thread on the cylindrical piece, it is necessary to grind the tool again and make another trial, continuing this until a tool with a correct flat is produced. The ideal method would be if the flat could be directly measured by micrometers, in which case there would be no uncertainties, and a correct tool could be produced more directly and with less work. It is, of course, not possible to measure with micrometers the distance AC in Fig. 1, as such a measurement would be at best uncertain for large pitches, and absolutely impossible to make on smaller ones, even when using an eyeglass. If, however, the vertical distance BD from the top of the thread down to the flat can be measured, the width of the flat is easily figured, as for a U. S. standard thread,

$$AC = 2BD \times \tan 30 \text{ deg.}$$

This distance can, of course, not be measured with ordinary micrometers, but a micrometer can be simply designed which may be used for obtaining this distance. Such a micrometer is shown in Fig. 3. If it were only a case of measuring a threading tool without clearance the angle CBD in Fig. 3 would simply need to be 60 degrees, and the micrometer so graduated that the reading would be zero when the face A of the measuring screw was exactly in line with the point B of the angle CBD. When wanting to measure the width of the flat of a threading tool, the tool would be placed in the angular space provided for it and the micrometer adjusted until the face of the measuring screw would touch the flat. The reading then should be multiplied by two times the tangent for 30 degrees or 1.155.

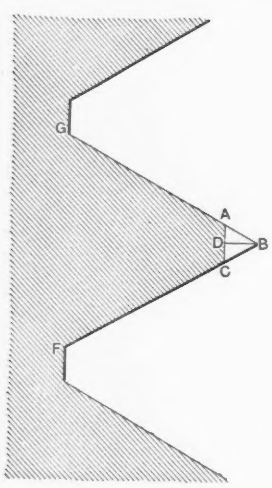


Fig. 1. Section of U. S. Standard Thread.

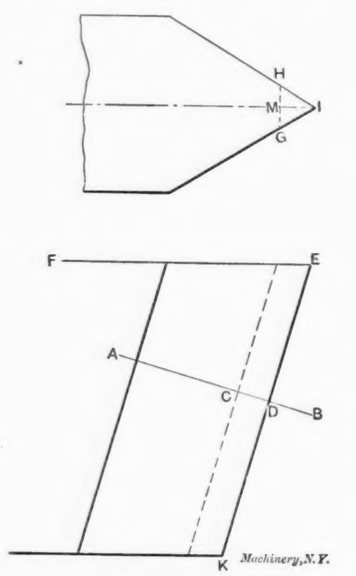


Fig. 2. U. S. Standard Thread Tool before Grinding Flat.

As the threading tool is provided with clearance, the case, however, is not quite so simple, but still presents no actual difficulties. Referring to Fig. 2, where a threading tool is provided with 15 degrees clearance, it is evident that the measurement taken by the micrometer will have to be along the line CD in a plane AB at right angles to the line EK. The length of the line CD is equal to MI multiplied by cosine of 15 degrees, or, reversing the expression,

$$MI = \frac{CD}{\cos 15 \text{ deg.}}$$

The width of the flat HG again is equal to $2 \times MI \times$ tangent for 30 degrees. Thus:

$$HG = 2 \times \frac{CD}{\cos 15 \text{ deg.}} \times \tan 30 \text{ deg.}$$

or in other words, the width of the flat of the threading tool equals 2 times the distance measured by the micrometers in the plane AB divided by cosine of 15 degrees, the quotient multiplied by the tangent for 30 degrees. We naturally would reverse the formula when wanting to produce a threading tool for a given pitch, the width of the flat HG being then given from the beginning and the distance we require to know being CD. Knowing this distance, we can grind down the sharp V-tool until we read off on the micrometer the required figure for CD. The formula for determining CD is:

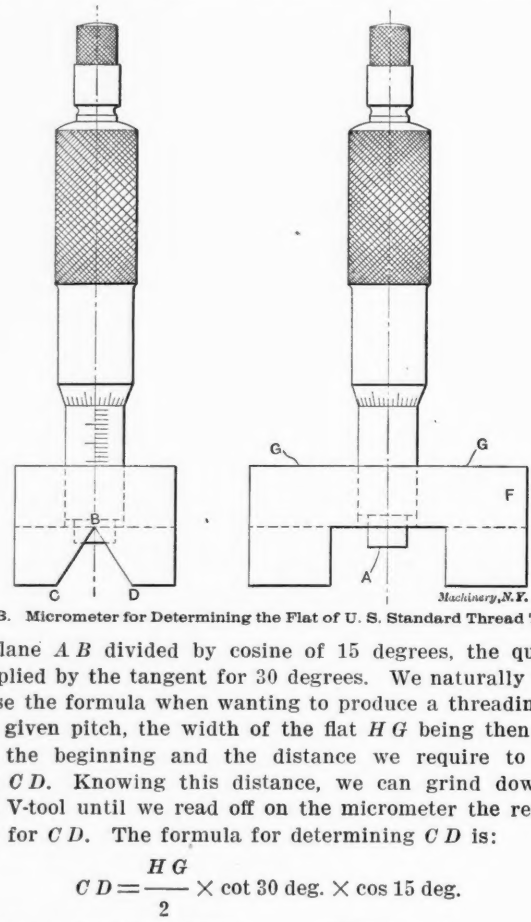


Fig. 3. Micrometer for Determining the Flat of U. S. Standard Thread Tools.

$$CD = \frac{HG}{2} \times \cot 30 \text{ deg.} \times \cos 15 \text{ deg.}$$

For U. S. standard thread,

$$HG = \tfrac{1}{8} \times \frac{1}{\text{No. of threads per in.}}$$

If N denotes the number of threads per inch, the formula may be written:

$$CD = \frac{\cot 30 \text{ deg.} \times \cos 15 \text{ deg.}}{16N}$$

In the table appended the values of CD are given for a number of United States standard pitches when the clearance angle of the tool is 15 degrees.

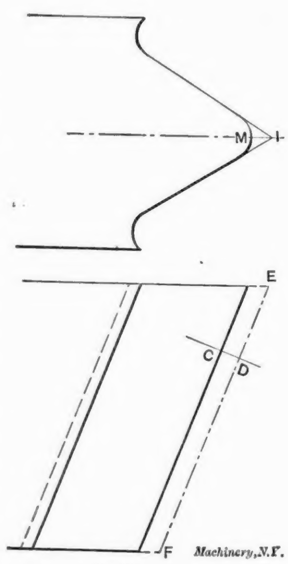


Fig. 4. Whitworth Standard Thread Tool.

Referring now to Fig. 3, the micrometer consists of an ordinary micrometer head fitted into a block F. This block is provided with an angular groove CBD to receive the tool. The angle to which to plane this block equals 61 degrees 44 minutes, which is the angle between the faces IH and IG in Fig. 2, measured in the plane AB. In the center of the block, where the micrometer head is attached, part of the block is

cut away, leaving a free view of the tool and the face of the measuring screw when the former is placed in position for measuring. The micrometer head used may either be an ordinary one with regular graduations, in which case the reading of the micrometer must be carefully noted when the face A of the screw is in line with the point B of the angular groove, but it is still better, if one wants to go to the expense, to make the head with a special graduation having the zero mark where the face and point of the angle coincide. In this latter case the graduations would evidently be made in a direction opposite to the one on an ordinary micrometer barrel. In the former case it would be necessary to subtract the measured reading from the reading when A and B coincide in order to obtain the length of the line $C D$ in Fig. 2. To facilitate the holding of the tool when measuring, it is advisable to knurl it on the top at G.

TABLE I. MICROMETER READINGS FOR MEASURING THE FLAT OF U. S. STANDARD THREAD TOOLS.

Clearance Angle 15 Degrees.

No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.
3	0.0349	13	0.0080	40	0.0026
3¼	0.0322	14	0.0074	42	0.0025
3½	0.0299	16	0.0066	44	0.0024
4	0.0262	18	0.0058	46	0.0023
4½	0.0233	20	0.0052	48	0.0022
5	0.0210	22	0.0047	50	0.0021
5½	0.0190	24	0.0043	52	0.0020
6	0.0174	26	0.0041	56	0.0018
7	0.0150	28	0.0038	60	0.0017
8	0.0131	30	0.0035	64	0.0016
9	0.0116	32	0.0033	68	0.0015
10	0.0104	34	0.0031	72	0.0015
11	0.0095	36	0.0029	76	0.0014
12	0.0087	38	0.0027	80	0.0014

TABLE II. MICROMETER READINGS FOR TESTING WHITWORTH THREAD TOOLS.

Clearance Angle 15 Degrees.

No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.	No. of Threads per inch.	Micrometer Reading.
3	0.0515	8	0.0193	20	0.0077
3¼	0.0477	9	0.0172	22	0.0071
3½	0.0442	10	0.0155	24	0.0065
4	0.0386	11	0.0141	26	0.0060
4½	0.0344	12	0.0128	28	0.0055
5	0.0310	13	0.0119	30	0.0051
5½	0.0281	14	0.0110	32	0.0048
6	0.0258	16	0.0097	36	0.0043
7	0.0221	18	0.0086	40	0.0039

TABLE III. MICROMETER READING FOR TESTING BRITISH ASSOCIATION STANDARD THREAD TOOLS.

Clearance Angle 15 Degrees.

British Asso. No.	Micrometer Reading.	British Asso. No.	Micrometer Reading.	British Asso. No.	Micrometer Reading.
0	0.0102	6	0.0054	14	0.0023
1	0.0092	7	0.0049	16	0.0019
2	0.0082	8	0.0043	18	0.0015
3	0.0074	9	0.0040	20	0.0013
4	0.0068	10	0.0036	22	0.0010
5	0.0060	12	0.0029	24	0.0008

This manner of measuring can be conveniently employed when testing or inspecting tools with round points like the tools used for originating the thread tools used to cut the Whitworth or the British Association Standard thread. In this case, the length of a line $C D$ from the point I to the highest part M of the radius measured in a plane at right angles to $E F$ as shown in Fig. 4, must be determined. The angle $C B D$ (Fig. 3) of the block must of course be made according to the angle of the thread which is measured. If the angle of the thread is v, the angle $C B D$ is determined from the formula

$$\tan \frac{C B D}{2} = \frac{\tan \frac{v}{2}}{\cos 15 \text{ deg.}},$$

provided that the clearance angle is 15 degrees. The values for the length of the line $C D$ measured on a tool with 15 degrees clearance angle are given in Table II. for the Whitworth standard thread and in Table III. for the most common pitches of the British Association standard thread.

* * *

THE SHOP DIRECTORY.

The shop directory is a new idea which is being introduced into the highly organized systems of modern manufacturing establishments. In practice it constitutes a not unimportant adjunct to industrial management, much more important than it may seem at first thought. To have the place of residence of every employe ready at hand must often prove a convenience. Occasion may arise when it must mean much more than mere convenience. In case of fire certain men might be needed immediately to furnish necessary information concerning the works. It may be the electrician, whose services are required to do emergency work. A man may not report for work and it may be necessary to communicate with him. In giving out overtime work men may be picked more judiciously, so that a minimum amount of hardship may result. There are occasions when the addresses of the men permit of using the mails for distributing literature or other mail matter.

The record goes further than mere residence. Something of the man's history is kept, whether he is married or single, and if he has children, information which is usually sought when it becomes necessary to reduce a working force. It is important to have a record of each man's usefulness as a workman, including the particular line of work at which he is employed, and also any other branch of work in which he has had experience. Where no such record exists—and few works have it—information concerning the workmen is frequently sought for various reasons and is gathered piecemeal, generally at the cost of some time and trouble. Occasionally it cannot be obtained. In large establishments, employing many hands, there is no one with even general information concerning all the working force. The superintendent cannot keep track of more than the older employes; his information is usually only that which comes with long contact with his men in the routine of his duties. Each foreman knows his own men pretty well if he has been long enough in his position, but there are always new men of whom no one has much knowledge. When a foreman leaves, his successor has to learn the force all over again. It is safe to assume that few foremen, in large or small establishments, could give the house address of a quarter of their men. The information needed for the shop directory is not difficult to obtain, as blanks distributed for the men to fill out will gather the necessary details, and as new men are employed each can fill out the same blank, and its contents be added to the general record.—*Open Shop.*

* * *

It is not unusual that our European friends form exaggerated opinions regarding the prosperity of this country, and the wages paid to all classes of labor. One of our English contemporaries has received reports of "abnormal" prosperity in the United States, and we do not censure the writer for using the word abnormal in view of the fact that "it is said that skilled workmen earn from 8£ to 12£ per week." From now on, let us not wonder why there come nearly a million immigrants to our shores yearly. The exaggerated prosperity claims of our own press have evidently been taken for plain truth on the other side; hence the story of our "abnormal" prosperity.

* * *

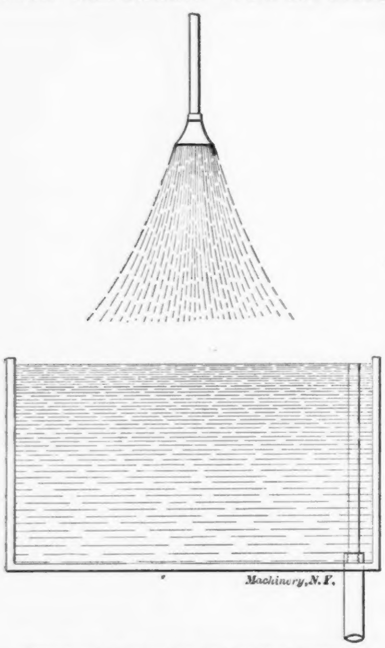
That the automobile has proven itself to be a commercial vehicle when put to use in a manner calculated to show results, and not only for advertising or similar purposes, is amply in evidence in the case of the London Motor Omnibus Co., which reports a gross revenue of $400,000 in a year and has just paid 10 per cent dividend. That, however, the automobile is as yet a great source of trouble is also in evidence, as we understand that out of 600 cabs used in passenger transportation in London on the average 200 are constantly in the repair shops.

A CASEHARDENING INCIDENT.

E. R. MARKHAM.

I was called to a shop not long ago to tell the owners, if possible, why they could not harden certain articles which were heated in a crucible containing cyanide of potassium. They had been hardening similar pieces made from the same grade of low-carbon steel for a long period, and had always obtained uniform results heretofore. In order that they might get the same results uniformly without frequent experiments, steel of a certain analysis had always been ordered, and from the same mill. To further safeguard against trouble it was the custom to make an analysis from drillings taken from several bars selected here and there from each shipment received. As the lot of bars from which the pieces being treated were made, did not show any material difference from those received before, the shop men were in a quandary to know why the work would not caseharden satisfactorily, inasmuch as it was treated exactly as previous lots had been.

The usual custom was followed in the use of cyanide; it was melted in a cast iron pot and heated until it was red hot. The pieces to be hardened were made from 0.30 carbon open-hearth steel, and were suspended in the red-hot cyanide and allowed to remain about three minutes. Then they were removed and plunged in a bath of water. But these pieces under consideration would not harden; they were found to be considerably stiffer than before given the treatment, but the surface was not hard and as this was a necessary requirement we started to investigate the matter.



Spray of Water for Producing Beautiful Effects on Casehardened Work.

I found upon inquiry that a new cast-iron crucible was being used, as the old one had developed a crack, and the hardeners thought that so long as the contents of the old crucible had been in use for a considerable time they would melt up a new lot of cyanide. After a few preliminary skirmishes which amounted to nothing in particular, we heated several of the pieces in an open fire and applied some of the new cyanide to them; then after reheating to a good bright red they were plunged into water. When tested with a file the pieces showed soft and, in fact, appeared to be in about the same condition as those heated in the crucible. Then several more pieces were heated and some of the old cyanide that remained in the old crucible, was applied and the pieces dipped as before. These showed a hard surface, thus proving that the new cyanide of potassium was at fault.

An examination of the cans in which the cyanide came showed it to be "50 per cent fused" cyanide, a low grade cyanide sold in cake form. Now, I had used fused cyanide for years in the treatment of gun frames which we wished to have the appearance of having been casehardened for color, but which at the same time were desired to be left in the soft state, and I then knew just what the trouble was. To make a long story short, 50 per cent fused cyanide does not carbonize the surface of iron, but if used in a certain manner it will give it the beautiful colors to be seen on the surfaces of pieces that are actually casehardened for color.

Perhaps it will not be out of place to give in brief the process employed when treating gun frames and similar pieces for imitation casehardening, the object being to get the characteristic coloring. The pieces are first polished nicely and then cleaned; they are then suspended by wires in a crucible of red-hot cyanide of potassium, the same as though a hardened surface were to be produced. In this case, however, the commercial article is not used, but 50 per cent fused cyanide is used instead. When the pieces have been in the fused cyanide for the desired length of time they are removed one at a time and dipped in the bath. This should be running water. If it be desired to produce the elegant vine-like appearance often seen on gun frames, the water should be delivered to the bath from an overhead pipe, as shown in the cut; the end of the pipe is fixed so as to spray the water, and the frame when taken from the cyanide is first passed through the spray and then immersed in the bath. The temperature of the cyanide has a great deal to do with the appearance of the work; if it be too hot the colors will not be as beautiful as though the work was heated only to a fairly low red heat.

If hardened surfaces are desired, the regular cyanide of potassium, carefully kept from the influence of the air, should be used; the depth of the hardened surface may be gaged by the time the pieces are left in the cyanide. At times it may be desired to give tool steel tool shanks or similar pieces the beautiful surface first described and still not leave them as hard as when taken from the bath. This may be accomplished by treating them as above described and then placing them in a kettle of oil over the tempering furnace and drawing to the desired temper. The heat should be accurately gaged by means of a high-temperature thermometer. It will be necessary to allow the piece to remain in oil until it is cooled off, or at least until it has cooled below 400 degrees F. Unless this is done the colors will change to temper colors. This effect is caused by the thin film of oxide which is always noticeable when polished surfaces of steel or iron are heated to a temperature above that mentioned. This fact is taken advantage of, of course, to denote the amount of heat absorbed by the pieces of steel when drawing the temper of hardened pieces.

* * *

At a time when it has been urged that rates for second-class postal matter should be increased in order to enable the postal department to be self-supporting, it is appropriate to call attention to the fact that undoubtedly the postal department would show a net profit instead of a deficit if it were not for the exorbitant railway rates that the postal department is forced to pay to the railroads for transportation of the mails. According to the *Medical World*, Prof. H. C. Adams, the railway expert for the United States Interstate Commerce Commission, has shown that the railroad receipts for 100 pounds of freight from New York to Chicago are on an average 75 cents, for express $1.25 and for mail $3.56; from New York to San Francisco the amounts would be $3 for freight, $6.75 for express and $13.28 for mail per hundred pounds. It appears that the railroads receive, on the average, for express 50 to 100 per cent more than for first-class freight, and for mail 100 to 300 per cent more than for express.

The express companies do not pay rentals for use of express cars. It does not seem reasonable that the government should pay rental for postal cars; consequently there is over five and a half million dollars' expenditure for which there does not seem to be any sufficient reason. Furthermore, the remaining $39,000,000 paid for mail transportation is paid on the basis of a rate of two or three times as great as that received by the railroads for the carriage of express. Prof. Adams estimates that the railroads receive for carrying the mails 12.56 cents per ton-mile; for carrying express they generally get from three to six cents per ton-mile; for carrying excess baggage, five to six cents per ton-mile; for commutation passengers, six cents per ton-mile; and for carrying the average of all freight, 0.78 cent per ton-mile. The mail is a sure, steady traffic, homogeneous, easily handled and does not require such expense as does baggage for storage, loading and unloading, etc., there being practically no cost but the cost of haulage. How inconsistent, then, that the government should pay more for the carrying of mails than is paid for any other similar service. It is unpleasant to use the correct name for this practice of the railroads to exact payment out of all proportion to the service rendered, and we will hope that the future will place our postal service on a more equitable basis.

ITEMS OF MECHANICAL INTEREST.

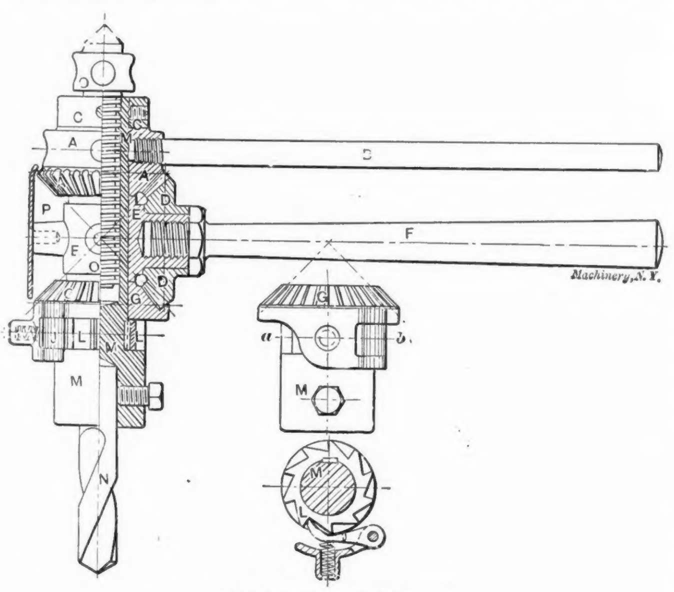
AN ABSURD GERMAN TOOL ADVERTISEMENT.

Successful advertising is said to be an art, but if this weird design, taken from a German engineering publication, is an example of the successful kind it would seem that sometimes it were closely allied to "black art." It may be merely the result of a vivid imagination overstimulated by beer and limburger, but whatever the cause, the "adsmith" has a good deal to answer for. Is it advertising or is it caricature to represent His Satanic Majesty's minions sharpening their pitchforks (or are they ice-picks) on a Bonner Fraeserfabrik milling cutter? A devil's imp might be able to hold a pitchfork against a milling cutter so firmly that the metal would be sliced off in large shavings to the accompaniment of fireworks, but *we* doubt it. The incongruity and absurdity of advertising machinery and tools in such a manner nowadays are too obvious for further comment.

German Tool Advertisement.

IMPROVED RATCHET DRILL.

The accompanying cut from the *Mechanical World* shows a variable speed ratchet drill made by J. Leslie Watson, Duke Street, Arbroath, England. The drill *N* is carried by a spindle *M* upon which the bevel gear *G* is mounted. This gear turns loosely on the spindle and has a projection, as shown in the detailed view. To this projection is fastened a pawl engaging with a ratchet *L* for rotating the drill. Intermediate gear *D* is carried by a sleeve *E*, into which latter the handle *F* is screwed. The upper gear *A* is, like gear *G*, free to rotate on the spindle, and is furnished with a handle *B*. The collar *C* keeps the three gears in mesh with one another, and a casing *P* is provided, which forms a guard around the gear teeth. The drill is fed in the usual way by the feed screw *O*.

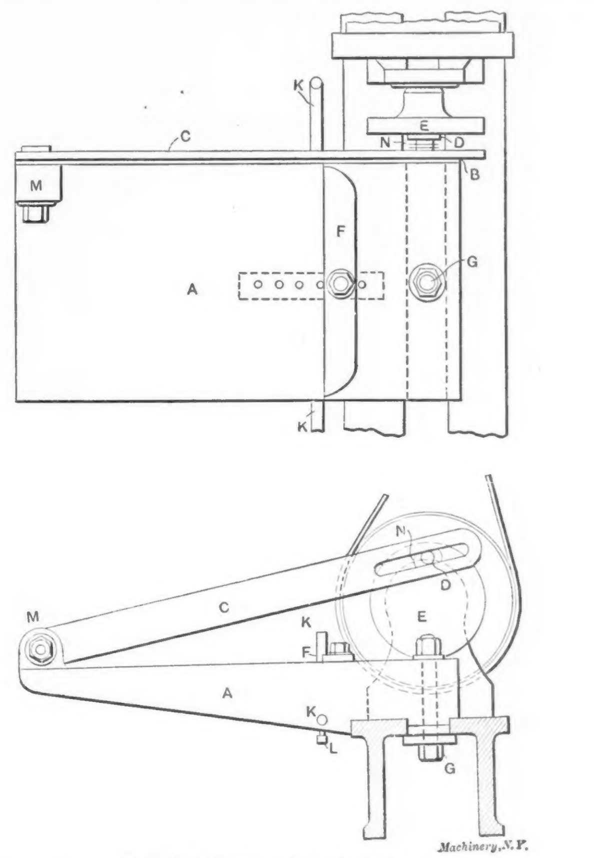


Variable Speed Ratchet Drill.

To use the brace in the ordinary manner, both handles are grasped with one hand and operated together. If *B* is turned to the left-hand side of the device and held while *F* is pulled toward the operator, the drill will turn at twice the ordinary speed; while if, with the handles still on opposite sides, both are drawn toward the operator, the speed of cutting will be three times as great as that obtained by directly operating the brace. The maker claims that with this brace he can drill, without extra exertion, a 9/16-inch hole through 1 inch of cast-iron in six minutes, or put the same drill through a ¾-inch steel plate in nine minutes. This he claims is 50 per cent quicker than by the ordinary type of ratchet drill.

SHEARING ATTACHMENT FOR THE LATHE.

The accompanying illustrations, taken from the *Practical Engineer*, shows a rig developed by an amateur for shearing sheets on the lathe. It consists of a casting *A* bolted to the lathe bed and having a boss at the outer end on which is pivoted the knife or shear *C*. The shear side of the casting is faced with a plain steel strip about ¼ x 2 inches section, held by fillister-head screws, and set at a slight angle from the vertical so as to provide clearance without the necessity of grinding to shape. The shear blade *C*, ½ x 2 inches, is slotted for a crankpin *D*. This crankpin is made in the form of a headless shouldered stud having a screw at the faceplate end which is inserted through a slot in the faceplate and held by a nut on the back side. A coil spring *N* between the shear blade and stud collar keeps the blade in close contact with the opposite cutting edge. The action of the shear is obvious and needs no further explanation.



Shearing Attachment for the Lathe.

* * *

There is, at the present time, a movement abroad in England to prevent any one from securing and holding a patent in that country unless it be worked in the United Kingdom. The president of the Board of Trade in London, in reply to a petition presenting the grievances of British manufacturers in regard to the non-working of patents granted to foreigners, is said to have stated that the law may be expected to be so amended that where patents are granted to foreigners the patentees will be compelled to work them in the country. A certain period will be fixed within which foreigners would be placed under the obligation either to work the patents themselves or to grant licenses to persons in the United Kingdom to do so. In the event of failure to make one of these arrangements within the stipulated time, the patent would become void. In Germany there is also a somewhat similar arrangement, although the law is not definite enough to prevent it from being easily circumvented.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

66-70 WEST BROADWAY, NEW YORK CITY.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1907.

PAID CIRCULATION FOR MARCH, 1907, 22,041 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

A BRAKE ON MACHINE TOOL DESIGN.

In speaking a few months ago of new principles in machine tool design the statement was made that nothing startling is being brought out at the present time. It would have been pertinent in that statement to have mentioned that some ideas in machine tool design, which are being held back, are held back because they are ahead of their time, as for example, pneumatic and hydraulic control. That fluid control of the functions of turret machinery, for example, will be in use in the not remote future is quite probable; at the present time, however, conditions are scarcely ripe, in that the operators and responsible mechanics of most shops are not educated to the point of being trusted with machinery having radically different features from those with which they are quite familiar. The toolroom and the functional system of machine shop control have not reached the general development which warrants the installation of machines that require a much greater expertness and specialized knowledge. For example, the success of the milling machine, we all know, is dependent on the state of the toolroom. Where the toolroom is primitive the milling machine is at a great disadvantage, but where it is up-to-date the milling machine is the peer and probably the superior of any other tool for rapid machining of formed surfaces. So it will be with the development of other machines having specialized and highly efficient features.

* * *

A PRIME FACTOR IN BUSINESS SUCCESS.

During the closing days of the Centennial Exposition in 1876, a young machinist, who bore a name which has since become known to mechanics and engineers the world over, was busily engaged in oiling and cleaning an exhibit of which he had charge. An older man who had been looking about the building for some time stepped into the enclosure and sat down to rest a few minutes, watching our friend meanwhile as he put his machinery in order. "Are you interested in machine tools?" asked the young man. "Yes," the other replied, "I have been building machinery for many years. I am Mr. ——, and that is our exhibit over there on the further aisle." The conversation thus started, he began to question the young man as to his training and present position, and his plans for the future. Finally he said: "I am going to risk giving you a little advice, if you don't mind. I have always kept before me, since I went to work in the shop as a boy, the thought that to-day I would do better than I did yesterday—would approach nearer, by a step, to the best possible. Our business is conducted in the same way. If last year we could build machinery with the vital dimensions correct within a limit of one thousandth of an inch, this year we will hold the limit down to one-half of a thousandth; next year we will do better still. I believe that, if a young man keeps some such idea as this before him, and is constantly guided by it, he does not need to fear that he will fail in making an honorable name and place for himself in the world."

Without doubt many successful businesses have been built up about some such aspiration in the thoughts of their founders. But who can travel about our country, visiting the well-planned and well-equipped shops with which it abounds, without feeling that the ruling thought in many of them is not "Let us do better work this year than we did last," but "Let us do more business this year than last, and make a greater profit in that business than ever before"? There is really nothing wrong with this idea; perhaps it is the only one that can successfully survive in this year 1907; the hard-cash, strictly business view-point should, in fact, never be neglected. But in the long run a strain of sturdy idealism will prove an important factor in building up a permanently successful business. The firm of which this old-fashioned mechanic was a member is still selling machinery, and more of it every year, and seems to be reaping in dollars and cents the fruits of the policy followed by its founders many years ago.

* * *

THE DISADVANTAGE OF TOO MUCH SPECIALIZATION.

In these days when so much has been said about specialization and about the necessity for any young man in the technical field to devote himself exclusively to a certain branch, it may be well to accentuate the point that specialization may be carried too far. The man who becomes too one-sided in his work may be useful to a less extent than he would have been, had he, while making a particular study of a special field, devoted some time to broaden his intellect in various ways. The truly great men of this as well as former ages are men who have not confined themselves to a small sphere of usefulness. It is true that it will not do to divide one's interests between too many things at a time. Do one thing at a time and do it well, but do not think that the time has come when general information in regard to all the things that surround us in life is useless simply because it is not possible to become a master of all the arts. Perhaps on the other hand there never was a time when the man with a broad view had a greater chance. The specialization in all lines of industry has limited the opportunities for the development of men of varied experiences, but such men are necessary for the executive positions. There is for this reason a premium on the services of the man who has been able to acquire a general, even if limited, knowledge of the industries, the business, and other conditions outside of his own branch. And because such knowledge is becoming more scarce, as the specialization becomes more systematized, there is all the more reason for not being deluded by the general outcry that a man to be truly successful must be a specialist.

To a certain limit the man who is a specialist, and nothing but a specialist, is more successful than his fellow workers; but this is in the secondary positions when he is working under the guidance of men who can supplement his lack of general development. When the moment comes that the place of managing the whole concern is to be filled, the specialist is left where he is, because he is filling his present place so exceedingly well, and the man who never was thought much of where but one of his many faculties came into play, is promoted to the place where he can give full sway to his general knowledge and his varied interests. And the specialist who in his one-sidedness thinks that he was the person logically fit for the promotion thinks himself badly ignored and his ability misunderstood; he does not realize that with all our specialization the "all around man" still holds his own.

PRINCIPLES OF DESIGN.

ENTROPY.

The designer to whom you refer in the editorial "Principles of Rational Design," which appeared in the Engineering Edition of the February issue, evidently believes the millennium to be sufficiently near at hand to be worth talking about. The cut and try method of design which you and he apparently expect to see done away with has been a mighty safe, though slow, process. It is the process by which has been done almost everything that has been done, notable exceptions being found in the fields of chemistry and electricity, where theories based, however, on the results of cut and try methods, have been the means of safely predicting the existence of hitherto unknown metals, or the means of producing designs by following set rules. An attempt to do what your designer suggests, will show at once the futility of attempting to fly straight at the mark in the present state of mechanical engineering. A few elementary things are well understood. The action of cams, of gears, and of link designs is easily predicted, and within reasonable limits their performance under severe duty as to wear and continued truth of action is assured, but when it comes to a choice, say of whether a certain motion in a machine shall be obtained by one form of cams or another or by gears or link work, then the problem becomes one which may permit of numerous solutions, any one of which may best suit a certain combination of other parts of the machine. Thus it may be possible to get a large number of different combinations of elements in a machine for producing certain definite results, all of which may work with equal efficiency. I have in mind just now a certain machine in the design and evolution of which I have had a hand. It is used to fold a peculiar material very much as envelopes are folded. After the folding, the finished product was to be stamped and pressed. The machine was built as a folder with a light press attachment as a subsidiary part. One piece in five minutes was all that we hoped to get. Experience with this machine showed that it could be run several times as fast as this, but that if we did so, the press was entirely inadequate. I have just redesigned this machine, and now it is a press with a folder attachment. I am not at liberty to say anything definite about this particular machine, but so far as I can find out there was and is no published data on which I could have based my conclusions so that I might have designed a better machine the first time. There was neither money nor time to do any experimenting with the material. The machine was designed on clear horse sense, nothing else. The second machine had no theory in its make up, except the theory that if the first one would do the work with an occasional breakdown, the second would stand up if made several times as strong. We are up to the limit of human endurance now to feed the machine. If we get up an automatic feeder we may have to redesign it for still greater capacity. The first machine may be said to have been designed all on theory, and when a practical man gets going on theory he runs wild. When you come to think of it, the worst lot of theory that you can strike comes from hard-headed practical men that don't know a sine from a wooden Indian. They have their practical experience, but they are dead sure that everything that looks just a little like a wheelbarrow runs just like one, wherein they are just as apt to run into trouble as the college chap that says it is a unicycle.

But to get back to the subject—when there is such a fund of experimental knowledge at hand that a certain set design has been found and proven by long use to be reliable—for instance look at bicycles—then the day of the designer is gone. There was a day when the expert bicycle designer was at a premium. He worked by horse sense too; now we know where the limits are, and we can have a good designer in that particular line for two dollars a day, unless they have all died or got into other lines of work; or better still, we can go and get a wheel by some good maker and change one or two dimensions and put it out as a new wheel. Just so long as design is uncertain, the skilled designer, the man who knows things mechanical, can draw a good salary, but as soon as a design may be predicted, so that there is only one design to suit one set of requirements, then the true designer leaves it for new fields, and the office boy turns out the designs by the aid of a set of formulas.

* * *

ALCOHOL, KEROSENE AND GASOLINE AS FUELS FOR AUTOMOBILES.

Automobilists who have been looking for practical tests upon which to base definite conclusions on the use of denatured alcohol as a satisfactory fuel, will find much to appreciate in the technical report just compiled by the official observers who accompanied the three Maxwell cars in their recent comparative fuel test run from New York to Boston. One of the cars used gasoline, one kerosene, and the other denatured alcohol. Under the strenuous conditions in which the run was accomplished, through snow and over bad roads, the results were far more successful than had been expected.

The main object of the test was to demonstrate that a modern gasoline car can be run successfully on alcohol or kerosene, if necessary, and to bring out the relative cost of operating it on either of the three fuels. But the greatest interest in the test was centered in the showing of the alcohol car, for it was the first attempt since the denatured alcohol law went into effect to make a long distance test under the official inspection of a committee of experts. The total distance traveled was 249 miles, long enough to allow of accurate comparison between the three fuels. The power developed by the engine using alcohol seemed fully equal to that developed when it was run with gasoline, and the pulling qualities of the engine when its speed diminished under load were remarkable, being the nearest approach to a steam engine that the committee of inspection had so far observed. This, of course, depends upon, that while the initial pressure obtained from alcohol is less than with gasoline, the mean effective pressure is greater. Despite the fact that the alcohol machine was the most heavily loaded, it opened its way through the snow and kept well ahead of the other cars. There seemed to be nothing lacking in power and speed. The kerosene car, too, showed good power and speed. Because of the lubricating qualities of kerosene the driver was able to run his car half of the distance without the use of lubricating oil in the cylinders. On account of its low cost kerosene would no doubt come into wide use, especially for commercial work, if some form of carbureter were introduced that would thoroughly gasify the liquid. Even though the consumption was great, on account of the low cost of kerosene it was the cheapest of the three fuels used. The car running on kerosene averaged 7.4 miles per gallon; the one using alcohol 6.13 miles, and the one using gasoline 10.1 miles per gallon of fuel used. The following table, showing the cost of the different fuels per gallon, and cost per ton-mile for each car, gives a good general idea of the comparative value of the different fuels:

	Weight.	Cost per Gallon.	Total Consumption, Gallons.	Total Cost of Fuel.	Cost of Fuel per Ton Mile.
Gasoline	2,270	$0.20	24.75	$4.95	$0.0169
Kerosene	2,520	0.13	33.75	4.39	0.0139
Alcohol	2,750	0.37	40.75	15.07	0.0448

From the above table it is seen that alcohol in its cost per ton-mile is about two and a half times as expensive as gasoline, and over three times as expensive as kerosene when used in the gasoline engine of the present day.

* * *

In a recently issued catalogue on high-speed drills the Cleveland Twist Drill Co. states that its tests and observations lead to the conclusion that it is well to start a high-speed drill at a peripheral speed of between 50 and 60 feet per minute (say 240 R. P. M. for a 7/8-inch drill), and to feed from 0.005 to 0.010 inch per revolution for drills over 1/2 inch diameter. Should the drill be running too fast it will wear away at the corners of the lips, and if the feed is too great the cutting edges will break or chip. When used in steel or wrought iron the drill should be flooded with lubricant or cutting compound; in brass use paraffine oil; and in cast iron an air blast. Spring in a drilling machine is very likely to cause broken drills when the point breaks through. Hence the high cost of high-speed drills makes it very important that they be used only in stiff, rigid machines.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The railway mileage of any country may be considered as a fair indication of its growth. That China is rapidly developing along the lines of western civilization is evident from the fact that the country now has 9,000 miles of railway in operation or under construction. According to the *Railway Age*, the Chinese Imperial Railways, 526 miles, paid 20 per cent on the capital outlay.

A 1,000 H. P. steam turbine installed in the locomotive works of J. A. Mäffei, Munich, Bavaria, by Melms & Pfenninger, G. m. b. H. of Munich, was tested by Prof. Schroeter. At 2459 R.P.M. and a load of 500 K.W. it showed a steam consumption of 17.1 pounds per kilowatt hour. The steam pressure was 176 pounds gage and the steam temperature was 319.4 degrees Centigrade. The design of the turbine is a combination of the impulse and reaction types.

According to the *Scientific American*, Germany is at the present time the leading country in the manufacturing and use of alcohol for light and power. Potatoes are the chief source from which alcohol is produced. One-eighth of all the tillable land in Germany is planted with potatoes and the yield is valued at $60 per acre. Nearly half of the whole crop is used in the manufacture of alcohol and starch. In France alcohol for manufacturing purposes is made chiefly from molasses and sugar beets.

According to *The Locomotive*, the total number of boiler explosions in 1906 was 431, which is 19 fewer than were recorded for 1905. There were 450 in 1905, 391 in 1904, and 383 in 1903. The number of persons killed in 1906 was 235, against 383 in 1905, 220 in 1904, and 293 in 1903; the number of persons injured in 1906 was 467, against 585 in 1905, 394 in 1904, and 522 in 1903. The average number of persons killed, per explosion, during 1906, was 0.545, and the average number of persons injured, per explosion, was 1.083.

Initial shipments of denatured alcohol have been made from distilleries in Peoria, Ill., being quoted at 31 cents per gallon, which will amount to about 36 to 37 cents in New York. The denatured alcohol bill having been in force only three months has had a remarkable influence on the price of wood alcohol, this latter having, according to the reports of the Department of Commerce and Labor, dropped from 75 to 45 cents. Evidently there must have been more or less of a monopoly in the manufacture of wood alcohol, when competition has been able to cut the price nearly in half within so short a time.

The speed of battleships will probably be subject to less variation than any other characteristic in the future. The speed of modern types of hulls may be represented very accurately by the formula:

$$S = 6.35 \sqrt[3]{\frac{H.P.}{D^{\frac{2}{3}}}}$$

where S is the speed in knots, $H.P.$ is the horsepower of the engines, and D is the displacement in tons. Designers seem at present to be of the opinion that the best results are obtained in the matter of all-around fighting efficiency by allowing 1 horsepower for each ton of displacement.—*Forrest E. Cardullo in Scientific American.*

During the months of August and September, this year, there will be held at Amsterdam, Holland, an international exhibition of machinery, machine tools and motors of various kinds. The exhibit is held under the auspices of the Society for the Advancement of Industry and is supported by the Dutch government and the city of Amsterdam. The exhibits are to be exempt from import duty. As Holland is a low-tariff country and with no important mechanical industry of her own, it seems as if this exhibit might offer a fair opportunity for foreign firms to introduce their goods in the Dutch market. Intending exhibitors are asked to communicate with Mr. T. M. Massis, Heerengracht 357, Amsterdam.

The wireless electric current transmission is now claimed to have made possible the production of electric light at a distance from the source of electrical energy. It is said that the Danish inventor, Valdemar Poulsen, who is well-known for his development of wireless telegraphy, has demonstrated before an audience of English scientists the possibility of wireless electric light. It is likely that some of the startling news in relation to the possibility of wireless transmission of electric current must be accepted with reservation, but there is no doubt that the developments of this branch of the electric science will prove to be one of the most important and, we might say, most wonderful.

After a long time of laborious research and experiments, two Belgians, Monge and Arzano have succeeded in perfecting a process by which they are enabled to metallize objects of very fragile nature, such as, for instance, fine laces, or a rose in full bloom. They have established a factory at 17 Rue d'Irland Saint Gilles, Brussels, with the object of placing finely finished metallized objects on the market, in every particular equal to, but at one-eighth the cost of, cast bronze. The process permits of perfectly duplicating the incomparable forms nature gives to her products, such as flowers, leaves, fruits, etc. The articles to be metallized are retained in a bath form 24 to 72 hours, and the finished articles appear to be made out of solid bronze.

According to the *Cologne Gazette* a new ocean liner will soon be built for the Hamburg-American Steamship Co. in the yards of Harland & Wolff at Belfast, Ireland. The new vessel is to be called the "Europa," and is expected to be launched in 1908. She will have luxurious passenger accommodations, including Turkish baths, elevators, a tennis court on the promenade deck, and a swimming tank, 75 x 25 feet. There will be accommodations for 550 first-class passengers, 350 second-class, 1,000 third-class, and 2,300 steerage. With the 500 men required for the crew, the vessel will carry 4,700 persons, the largest of any of the transatlantic liners. The new vessel will have a speed of 19 knots, a displacement of 42,000 tons, a length of 750 feet, and a beam of 80 feet.

The Metropolitan Life Insurance Co., New York, has announced its plan for a 50-story tower which will rise 690 feet from the foundation. It will be built in completion of its marble office building covering the block between Madison and Fourth Avenues and 23d and 24th Streets. It will be five stories higher than the Singer Building tower now in process of construction. The tower will have 75 feet frontage on Madison Avenue and 85 feet on 24th Street. The height above the sidewalk will be 658 feet. A huge clock face will be a feature of the tower at a height of 346 feet above the sidewalk. The dial will be 25 feet in diameter and the hands 12 feet long. Six express elevators will be installed in the tower, four of which will terminate at the 42d story.

Japan is immensely rich in water power, the aggregate of which is estimated at some 1,000,000 horsepower. More than a hundred smaller waterpower installations are already in existence, and some very important ones are being constructed. Among the latter is a power station for Kioto, with a canal of 7 miles in length, and a fall of 110 feet. The capacity of this station will be 4,400 horsepower. The power station for Tokio, on the Tamagava River, will have 20,000-kilowatt transmission, with a 40,000-volt tension, over a distance of rather more than 25 miles. Another large station will be placed between Kioto and Osaka, which towns lie at a distance of about 40 miles, and this installation is calculated at 32,000 kilowatts. Japanese enterprise has also brought some waterpower installations into Korea.—*Engineering.*

The manufacturers of an English motor car, known as the Siddeley, have introduced a substitute for the pneumatic tire. Although it is doubtful whether the new introduction altogether solves the difficulty due to the liability of puncture of the ordinary tire, there is no question that the new tire acts as an excellent compromise, and at the demonstration given in London some extraordinary results were obtained. The new tire is known as the elastes tire, and has derived its name from a solution called elastes, which consists of glue, glycerine and chromic salts mixed at a high temperature. This mass injected into the inner tubes used with the covers of ordinary pneumatic tires solidifies in a few days into a soft rubber, rendering the combination a soft cushion tire fit to combat roads of all conditions. The advantages claimed for "elastes" filled tires are entire immunity from puncture, longer life of covers, and ultimate saving in running cost. It is calculated that a set of elastes tires will run for at least 10,000 miles fitted to a 24 horsepower car. The experiments prove that half the price of tires can be saved through the use of "elastes." From this it would appear that a decided step has been taken toward a perfect type of tire.

Assuming the steam consumption of the turbines of the new Cunard steamship *Lusitania* to average 15 pounds per horsepower-hour when the turbines are developing 65,000 H.P., it has been calculated that the boilers will have to evaporate each hour 435 tons of water, which would call for the consumption of 50 tons of coal per hour, or 1,200 tons per day. As the turbine requires for economical working a high vacuum it is assumed that the condensers will call for about 50 pounds of circulating water for each pound of steam condensed. This means an hourly passage of 21,750 tons through the circulating pumps, or 522,000 tons per day. Each pound of coal consumed will require the passage through the furnaces of 14 pounds of air, making a total of 700 tons per hour, or 16,800 tons per day. This is equivalent to 21,000,000 cubic feet of free air per hour. With the average trip estimated at five days it will be seen that the coal consumed will amount to 6,000 tons. The water evaporated will total 52,200 tons. The work of the circulating pumps will be represented by the passage through the condensers of 2,610,000 tons of water, or 60 times the entire weight of the ship and contents. The air required for the furnaces will be 84,000 tons.—*Iron Age.*

Denatured or industrial alcohol is sold by the Swiss government at cost—about 25 cents per gallon. There are two methods of denaturizing the alcohol, the complete and the incomplete. The complete method is applied to spirits which are to be used for heat, light, and power purposes. This alcohol is fully denatured; pyridin is used as a base. Incomplete denaturization prevents the alcohol from being used as a beverage, but does not destroy its properties for special uses. The process of denaturizing varies according to its intended use. To each 100 parts absolute alcohol the following substances are added: (1) For vinegar: 5 parts absolute acetic acid mixed with at least 200 parts water. Wine or beer may be substituted for the water. (2) For varnish, polishes, etc.: 2 parts wood alcohol and 2 parts benzine, or ½ part turpentine oil, or 5 parts wood alcohol, or 4.4 pounds shellac, or 4.4 pounds copal rosin, or 1.1 pound camphor. Camphor may be used only by firms using the finished product in their own factories exclusively. (3) For paints and colors: 10 parts sulphuric ether, or 1 part benzol, or 1 part coal-tar oil, or ½ part turpentine oil, or 25 grammes bone oil, or 25 grammes aniline blue (or eosin, or violet, or fluorescin), or 100 grammes naphthaline, or 4.4 pounds technically pure methyl alcohol, or 1.1 pound camphor.

CONDITION OF STEAM TURBINE AFTER LONG TIME OF SERVICE.

Power, December, 1906.

After eleven months' run a turbine in the power station of the Baltimore Power Company was dismantled for the purpose of inspection. A thorough examination after so long a time of more or less constant service shows the following results:

The general condition of the machine was found to be as good as it was at the start; no blades were found missing; the blades were in excellent condition, although a slight surface oxidation was noticed, due to condensed steam remaining in the cylinder while the machines were out of commission; the bearings showed no wear; nor was there any wear on the shaft; in fact, the original marks of the scraper tools were plainly visible over the entire wearing surface of the bearings, which proves that the rotating element is supported on oil films; the governing mechanism was perfect, with the exception of two inexpensive knife edges, which were replaced; lost motion had not developed in this device, and the governing was as positive and sensitive as when first installed.

The whole plant referred to has been running for a year with twenty-four hours' service; no troubles of serious nature have arisen, and practically no repairs have been necessary excepting of a minor character. Once one of the bearings ran warm, but this was due to shortage of oil in the lubricating system. A copper expansion joint located on one of the equalizing pipes fractured, but no trouble resulted, and it was replaced by another. These facts being taken into consideration, it is the opinion of Mr. Josselyn, the vice-president and manager of the operating department of the Baltimore Power Company, that from an operating standpoint the steam turbine has proven eminently successful for central station service.

MAKING ALCOHOL FROM SAWDUST.

The Engineer, Chicago.

Wood alcohol is made by the dry distillation of wood, that is, by heating wood in the absence of air, under which condition vapors are given off and charcoal left behind. The vapors are then cooled and condensed to a liquid, which is separated into its constituents, one of which is wood alcohol. Some 50 years ago a chemist discovered that by boiling sawdust for a long time in a fairly strong acid, it produced a sugar which could be fermented to ethyl alcohol. The yield he obtained, however, was too small to make the process of any commercial value. The first process to have even a vestige of commercial value was that of Simonson, a Swedish chemist, who proposed to treat the sawdust in three times its weight of strong sulphuric acid at a high temperature and pressure. Even this method, however, was difficult and expensive and did not give a good yield of alcohol. A number of patents were issued which were merely variations of this process, among them being that of Classen, a German chemist, who treated the sawdust with strong acid and afterward submitted it to hydraulic pressure. Not satisfied, however, he went on, gradually perfecting a method, and finally about three years ago he patented a process which is now in successful operation in this country.

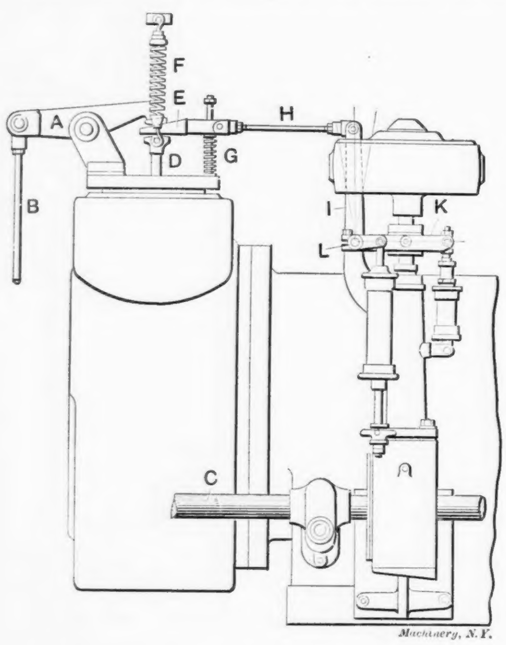
The process is, shortly, as follows: Sawdust, or wood waste, in pieces up to the size of a lead pencil is dampened and placed in a large cylinder which is lined with lead so as to resist the action of the acid used during the process. Sulphuric acid is then introduced in the proportion of one part 3 per cent sulphuric acid to three parts of wet sawdust. The cylinder is revolved in order to thoroughly mix the contents, which are rapidly heated up to 300 degrees F. The mass is kept at this temperature and under pressure for an hour. Then the steam and acid are blown off, and the acid is saved to be used again. The sawdust is thoroughly washed with water in order to abstract all sugar which has been formed. This solution is then treated with lime to neutralize the small amount of acid it contains and heat is added. Fermentation begins almost immediately and is practically complete after 8 hours. After the fermentation is complete, the liquor is distilled and the alcohol purified in exactly the same manner as the alcohol from corn, and the resulting product is ethyl alcohol, differing in no way from the best grade of ethyl alcohol produced from grain, potatoes or molasses. The yield is excellent, amounting to 25 gallons of absolute alcohol per ton of wood, and this value is about the same for all available woods.

GOVERNING DEVICE FOR INTERNAL COMBUSTION ENGINES.

The Mechanical Engineer.

This method of governing internal combustion engines, named after its inventor, A. R. Bellamy, of Stockport, England, is founded on the well-known method of the interposition of a wedge-shaped block between the valve stem and the lever actuating the valve.

As seen from the cut, a small lever *A*, which is oscillated by a connecting-rod *B* and crank or other mechanical device through the medium of a cam on the side shaft *C*, is fitted to a pivot. Between the free end of this pivoted lever *A* and the stem *D* of the valve admitting explosive mixture to the engine, is disposed a wedge-shaped or inclined block *E* interposed in such a manner that the pivoted lever acting on the wedge-shaped block brings the face of the same into contact with the stem of the mixture valve, thus opening the valve against the action of the spring *F* on each oscillation of the lever *A*. A compression spring *G* may be employed to maintain the wedge or inclined block *E* always in contact with the lever *A*. The inclined block *E* is pivoted to a spindle or rod *H* connected to a lever *I*. This lever *I* is secured to a rod *L* mounted in suitable bearings. To the rod *L* are also connected levers *K*, which are actuated by the governor of the engine. The oscillating movement of the levers *I* and *K*, indicated by light center lines in the cut, in answer to the calls of the governor, reciprocates the rod *H* and causes the wedge-shaped block *E* to be correspondingly moved laterally between the end of the pivoted lever *A* and the stem *D* of the mixture valve. When the load on the engine is light the levers *I* and *K* move the thinner end of the wedge *E* above the point of the stem *D* of the mixture valve, leaving a gap between the wedge and the valve stem. The pivoted lever *A* therefore oscillates the wedge *E* some little distance before the inclined wedge can come into contact with the valve stem *D*, and the mixture valve is opened to its smallest extent. This opening of the mixture valve is gradually increased to a maximum as the governor slides the inclined wedge until the thickest part of the wedge comes into contact with the valve stem. When the wedge *E* is pulled right away from between the valve stem and the oscillating lever, such as would happen if the engine "raced" or "ran away," the lever *A* would be incapable of opening the mixture valve at all, thus cutting off entirely admission of explosive mixture to the engine.



Governing Device for Internal Combustion Engines.

CONCLUSIONS AS TO THE STABILITY OF STEEL FRAME BUILDINGS.

Some interesting conclusions on the stability of tall steel frame buildings have been made public by Mr. Frank B. Gilbreth, a well-known contractor of New York City, who is at the present time reconstructing the eight-story steel frame Mutual Life building in San Francisco. He believes that there is no reason to fear structural damage in tall buildings in San Francisco or any other city by an earthquake as severe as that of April 18, 1906, provided the buildings are properly designed and constructed. The Mutual Life building which, though only eight stories, is taller than the average ten-story building, was built thirteen years ago on made ground, and passed through the earthquake without a structural blemish. However, the subsequent fire damaged it to such an extent as to necessitate the removal and reconstruction of the upper six stories. This gave the contractor an unusual opportunity to investigate the condition of a modern structural steel building which had been subjected to an earthquake shock and afterwards to a severe fire. The result of his investigation is given as follows:

1. A steel frame, properly painted and buried in masonry, will not rust enough in thirteen years to affect its strength any measurable amount.
2. The better the steel is coated with mortar the less it will rust.
3. Portland cement is better than lime mortar for imbedding steel to prevent it from rusting.
4. Unpainted iron rods buried in mortar composed of lime and a large proportion of Portland cement, rust very little, certainly not enough to impair their strength.
5. Columns should be of such cross section that they can be thoroughly imbedded in Portland cement, avoiding a hollow column unless latticed and filled with very soft concrete.
6. Wherever possible, preference should be given to those shapes of steel that present the least surface to the action of rust.
7. If steel is not thoroughly cleaned from rust before it is painted, the paint will not greatly retard the progress of the rust.
8. It is much easier to cover steel thoroughly with concrete than with brick masonry. If brick masonry is to be used the bricklayer should thoroughly plaster the steel work ahead of the brick work.
9. The quality of the paint used, though important, is not so important as surrounding every part of the steel with Portland cement.
10. Interior columns do not rust as much as exterior columns.
11. Cinder concrete does not injure to the slightest degree a steel floor beam that has been painted.
12. No pipes or wires should ever be placed behind fireproofing, as they will buckle with the heat and push off the fireproofing.
13. This building probably could have been saved intact if it had had fireproof exterior door and window-frame with wire glass and an emergency water tank on the roof.
14. Terra cotta blocks are not as good as concrete for fireproofing interior columns, nor do they protect the steel from rusting as well as does Portland cement concrete.
15. Neither marble nor any of the well-known kinds of plaster will withstand heat. There is a great demand for some durable material that can be worked as easily as can wood or plaster, but which will resist great temperature.

EFFECT OF DURATION OF STRESS ON STRENGTH AND STIFFNESS OF WOOD.

Trade Bulletin 10, Forest Service, United States Department of Agriculture.

It has been established that a wooden beam which for a short period will sustain safely a certain load, may break eventually if the load remains. For instance, wooden beams have been known to break after fifteen months under a constant load of but 60 per cent of that required to break them in an ordinary short test. There is but little definite and systematic knowledge of the influence of the time element on the behavior of wood under stress.

This relation of the duration of stress to the strength and stiffness of wood is now being studied by the Forest Service at its timber-testing stations at Yale and Purdue universities. The investigation will determine the effect of a constant load on strength, the effect of impact load or sudden shock, the effect of different speeds of the testing machine used in the ordinary tests of timber under gradually increasing load, and the effect of long-continued vibration.

To determine the effect of constant load on the strength of wood, a special apparatus has been devised by which tests on a series of five beams may be carried on simultaneously. These beams are 2 x 2 inches in section and 36 inches in length, each under a different load. Their deflections and breaking points

are automatically recorded upon a drum which requires thirty days for one rotation. The results of these tests extending over long periods of time may be compared with those on ordinary testing machines, and in this way safe constants, or "dead" loads, for certain timbers may be determined as to breaking strength or limited deflections.

The experiments of the Forest Service show that the effects of impact and gradually applied loads are different, provided that the stress applied by either method is within the elastic limit of the piece under test. For example, a stick will bend twice as far without showing loss of elasticity under impact, or when the load is applied by a blow, as it will under the gradually increasing pressure ordinarily used in testing. These experiments are being extended to determine the general relations between strength under impact and gradual loads.

Bending and compression tests to determine the effect of the speed of application of load on the strength and stiffness of wood have already been made at the Yale laboratory. The bending tests were made at speeds of deflection varying from 2.3 inches per minute to 0.0045, and required from twenty seconds to six hours for each test. The woods used were long leaf pine, red spruce, and chestnut, both soaked and kiln dried. From the results are obtained comparable records for difference in speeds in application of load. A multiplication of the results of any test at any speed by the proper reduction factor, derived from these experiments will give equivalent values at standard speed. The tests also show concretely the variation of strength due to variations of speed liable to occur during the test itself. The results plotted on cross-section paper give a remarkably even curve as an expression of the relation of strength to speed of application of load, and show much greater strength at the higher speeds. A numerical expression of the law, averaging all species, both wet and kiln-dry, gives the following table, which shows the increase in strength with the increase of speed of test:

Minutes to Move Crosshead one inch.	Ratios of Ultimate Strength. Compression.	Bending.
900	100	100
350	100.8	100.9
150	102.3	107.3
40	106.9	110.1
5	113.8	118.7

The first column, which gives the number of minutes required to move the crosshead of the testing machine over the space of one inch is the reciprocal of speed. The second and third columns give the effect of this increase of speed upon compression and bending, respectively, and show that strength increases with speed. The strength at the lowest speed is arbitrarily fixed at 100 as a convenient basis for comparison. The ordinary bending-test speed for small specimens is one-tenth inch per minute, or, reciprocally, ten minutes are required to move the crosshead one inch.

It is common belief among polemen that the continual vibrations, to which telephone poles are subjected, take the life out of the wood and render it brash and weak. Nothing is definitely known as to the truth or falsity of this idea. Tests will be undertaken to determine the effect of constant vibration on the strength of wood.

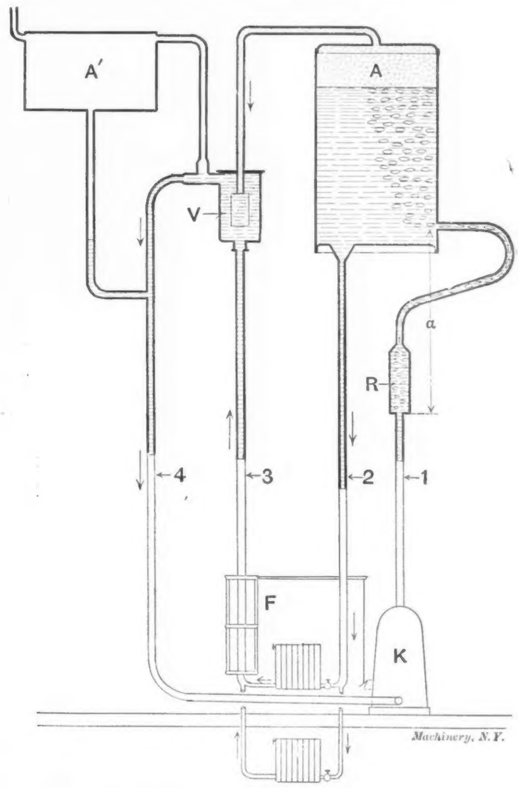
A RAPID CURRENT HOT WATER HEATING SYSTEM.

Engineering News

A rapid-current heating system has the advantage that small pipe may be used with consequent lower cost in constructing the pipe circuits as compared with ordinary warm-water heating systems. Such a system has recently come into extensive use in Germany and England, and is known as the Brückner system, after its inventor. The rapid circulation of the water is produced by a short length of pipe in which steam separation and emulsion take place.

Referring to the cut, K represents the boiler, R the regulator, A a closed expansion tank, A' an open safety tank, V the condenser and F the draft regulator. The boiler is in direct communication with the safety tank A' through the return pipe No. 4. Thus the system is of the open warm-water type. When the temperature of the water leaving the boiler rises above the boiling point, vaporization begins in pipe No. 1, steam bubbles are formed in the rising pipe, and the flow to the expansion tank A is composed of a mixture of water and steam, the specific gravity of which is much less than that of water alone. In expansion tank A the steam bubbles rise to the surface of the water, and the pressure forces them through the pipe at the top of the expansion tank to the condenser, while the heated water containing no steam, finds its way to the radiators through pipe No. 2.

Disregarding the difference in specific gravity between the water columns in pipes 1 and 4, and 2 and 3, it follows that the circulation power, or motive force, obtained depends entirely upon how much the total weight has been reduced by the length of the column of mixed steam and water, *i. e.*, by the specific gravity of the emulsion column a, if we assume that separation begins, under normal conditions, near the



Rapid Current Hot Water Heating System.

lower edge of the regulator and that the rising pipe enters the expansion tank A just above its bottom. In the Brückner system, at least with moderate circulating heights, it is claimed that only about two-fifths of the sectional pipe area is required compared with a low-pressure steam heating system of the same capacity.

The water flows into the radiators, as a rule, at a temperature of about 210 degrees F., and as the water should always enter and leave the radiators from below whenever possible, the average normal temperature of the water in all the radiators will be about 185 degrees F. The second expansion tank A' is simply a safety tank for equalizing the pneumatic pressure produced by firing, and for the purpose of receiving an extra flow of water caused by too hot a fire.

MAKING SEAMLESS STEEL TUBES.

The following article on the manufacture of seamless steel tubing, for boiler tubes and other purposes, is taken from the *Pittsburg Dispatch*, a daily newspaper. While not at all technical, it is as good a description of the process as could be given without going into details at great length. The plant spoken of is the Shelby Steel Tube Company's mill at Greenville, Pa.

The steel reaches the tube mill in blooms six inches square, each weighing about 750 pounds. This bloom is put into a continuous heating furnace, which has a capacity of 150 blooms, and remains there until ready to be rolled. It is then taken from the furnace by an automatic conveyor to what is known as the 20-inch bar mill. Here the bloom is rolled into a solid round billet about 3½ inches in diameter. From the rolls the billet is carried by conveyors to the hot saws, where

it is cut to the required length of about 37 inches, each piece weighing somewhere near 80 pounds. These smaller billets then go through an underground passage to the steel yard, where they are stacked in piles and allowed to cool. The systematic inspection of the tubes begins at this stage of their manufacture. Company inspectors here give each section of the steel a slight inspection before it is transferred to the furnace which heats it for the piercing operation, the most important step in the making of seamless steel tubes. In this furnace the steel is brought to almost a welding heat, is taken from the furnace and put into the rotary piercing mill, which revolves the billet at 1,500 revolutions a minute, at the same time forcing it over a plug, and in fifteen seconds the solid steel billet is converted into a seamless tube nearly 8 feet long, 4 inches diameter and 1/4-inch wall.

The tube is now picked up by another automatic conveyor and carried to the reheating furnace, where it is again brought to almost a welding heat and then carried to the two-high rolls, where it is subjected to six operations over a plug, elongating the tube to a length of about 19 feet, reducing its outside diameter to 3 1/4 inches, and the thickness of wall to 7-32 inch. The tube is next taken to the pointing hammers, where it is pointed for the cold-drawing operation, and after this it goes to the pickle house, where it is put into a strong solution of boiling blue vitriol acid which removes all scale and cinders or other foreign matter, leaving the surface absolutely smooth. A composition of tallow and flour is then applied to the tube, giving it a coat to reduce the friction during the cold-drawing.

After waiting long enough for the grease to dry, the tube goes to the draw bench, where it passes through the first cold-drawing operation, which consists of putting into the tube a mandrel and then drawing it through a round die. This process, by stretching the metal, elongates the tube, thins the wall, and smooths it both on the inside and outside. After the first cold-drawing, the tube is taken to the open-furnace annealing oven, where it remains for about half an hour, or until thoroughly annealed. Then the tube is again put through the pickle solution to take off the scale and dust accumulated during the annealing. It is again given the tallow and flour treatment, and taken to the draw-bench. This is repeated until the tube is of the required diameter and gage.

The tube is now ready for the finishing department, where it passes through the final operation before the first government inspection. This consists of straightening and cutting to length. At the first inspection the government inspector is required to examine each separate tube for surface and gage; from each one hundred tubes thus inspected he picks at random one tube for the elongation test, and two or three short pieces to be used for the crushing and flattening tests. These are stamped with the government stamp, and taken, with the other tubes to be again annealed, to a retort furnace; this because no air is allowed to strike the tubes during this last annealing or the cooling which follows it. When cold the tubes are removed from the retort and go to the straightening machines, where they are straightened for the last time. They then go to the shipping room to await the government test for elongation and strength. B.

CENTRIFUGAL PUMPS.

Abstract of Part of Paper Read by William G. Gass before the Manchester (England) Association of Engineers, December 7, 1906.

The credit of bringing the centrifugal pump on to a working basis is usually given to Appold, but long before his time, however, the centrifugal fan was at work, for as far back as 1713, Papin, the celebrated French engineer, designed one, and others have been made, both in England and America.

In the development of centrifugal pumps a variety of types have been evolved, but in all cases the pump consists of an outer portion, referred to as the casing, in which the inlet and outlet passages are formed, and which encloses a revolving wheel, impeller, fan, rotor, disk, runner, piston or bucket, these being various names for it.

Classes of Centrifugal Pumps.

Centrifugal pumps may be divided into four general classes or types which we, for simplicity, will refer to as types *A*, *B*, *C* and *D* respectively. Two sections of type *A* are shown in Fig. 1; the bucket is shown by dotted lines. This type has a single inlet central to the casing. It has no expanding chamber and is usually made only in smaller sizes, say up to about 6 inches diameter of inlet and outlet. The outlet is, as a rule, placed vertically as shown. The casing is divided in the center and the two halves bolted together. Fig. 2 shows a variation of this type with expanding chamber, and with an elbow fitted to the inlet which sometimes is used to form a support for the end of the shaft and provided with a stuffing box and gland. Type *B* is shown in Fig. 3. This

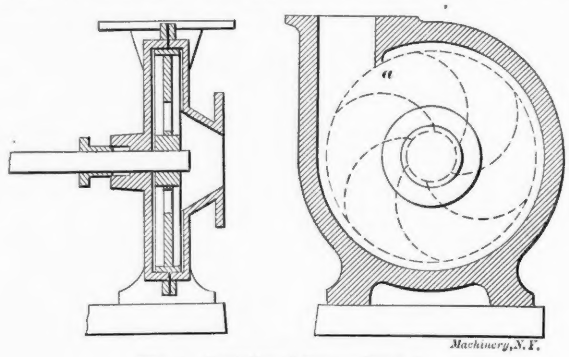


Fig. 1. Centrifugal Pump—Type A.

type is quite popular, and pumps are made after this pattern up to the largest sizes. The inlet and outlet shown at right angles may be made at any angle in regard to one another. The casing is divided in the horizontal and sometimes also in the vertical center line, and in some cases a segment is fitted which permits the bucket and the shaft to be lifted out. In this type the expanding chamber is provided for by the eccentricity of the axis of the shaft with regard to the external periphery of the casing, and in the larger sizes by the additional widening of the body toward the outlet. The inlet is branched and the incoming water divides into two streams, giving what is known as the double inlet or balanced type, the idea being that the two streams of water entering from opposite sides balance themselves and remove any end thrust on the shaft.

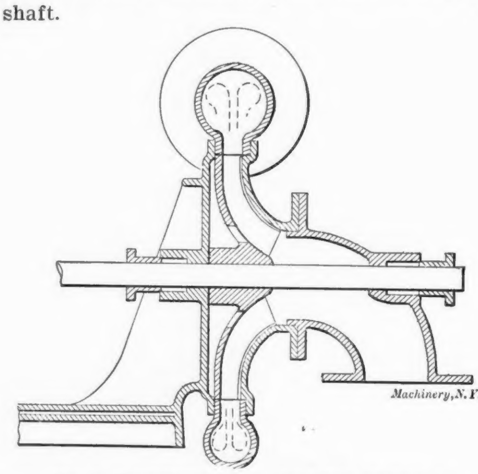


Fig. 2. Centrifugal Pump—Variation of Type A.

Type C, Fig. 4, is another form of the balanced or double inlet type, in which the expanding chamber is external to the diameter of the bucket and circular in section, but of increasing diameter, the space between the tip of the bucket arms and the expanding chamber being approximately parallel in section and circular in form. Type D, Fig. 5, has a single inlet, the expanding chamber developing external to the diameter of the bucket, but the continued development of which is carried out behind that part of the casing against which the bucket runs. The cuts of these four types show them all with the shaft horizontal and the buckets vertical, but they will any of them work equally well with the shaft vertical and the bucket horizontal; they would then, however, require some special form of bearing to carry the weight of the shaft.

Construction of the Bucket.

Our next point for consideration is the bucket, the portion of the pump which may be said to do all the work. We find that there are two classes of buckets only, which are, the closed type, Fig. 6, and the open type, Fig. 7.

In the closed type the vanes are carried from the hub but are covered in on either side, leaving a space in the center on each side through which the water enters, and is confined between these covers until it leaves the bucket and is discharged into the casing; a dividing plate attached to the arms prevents the two streams coming directly in contact as they enter the bucket. This type of bucket is used in pumps of Type B, and is occasionally used in a modified form in both forms of Type A, in which case it has a single inlet only. In the open type, which is generally used in pumps of Type C and D, the vanes are not enclosed, but run between the faces of the casing which encloses them, and when used in the double inlet pump have a dividing plate to prevent the entering streams striking each other. The cut shows a bucket of the double inlet type, but they are made of the single inlet as well.

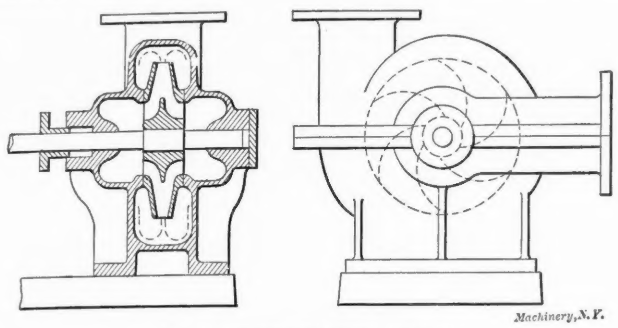


Fig. 3. Centrifugal Pump—Type B.

In both types the vanes are generally curved backward to the direction of rotation, although occasional makers use straight arms inclined backward in a similar manner; they are usually six in number, though four and eight are sometimes used, and occasionally, though very seldom, more than that number. The radius of curvature is given differently by different writers on the subject, but makers seem to each arrive at a form of curve which they find suits their requirements best.

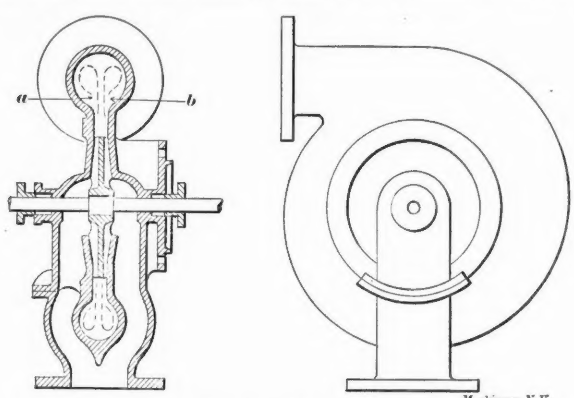


Fig. 4. Centrifugal Pump—Type C.

If the bucket were made exactly and mathematically correct we ought to have a different curve of vane for every change of speed and lift, but for manufacturing purposes it would involve so great a number of patterns as to be impracticable, and a compromise has to be made. In the diagram, Fig. 8, is given a simple method of striking the curve of the vanes which works very well, both for open and closed buckets up to large diameters, and which is in effective operation for lifts of 60 feet and over with best results. The method of laying out is as follows: Divide the circle representing the diameter of the bucket into six or any number of arms desired, bisect each radii, then using this bisected point as a center, and with a radius $BC = AB + 1/6$ of AB, draw the curves which represent the working face of the vanes of the bucket. The back of each vane can be made to give a thickness suitable to the material of which the bucket is to be made. Different firms have different methods, but this is simple and easily understood by any workman who has to make the pattern, and is very effective.

As an argument against the open bucket is the statement that it is possible to make the closed bucket a better fit between the facings than the open one, and thus there must be more leakage in the latter bucket than in the other; but this is not so, as they can both be made with the same clearance to begin with, and there is no more wear in one case than in the other. As far as the centrifugal effort is concerned, there is not any great difference between them, the slip in both being about the same. In some cases in the closed type—in order to reduce the leakage—one, two, or three facings are employed, with extra vanes on the outside to give a pressure between the facings; but additional facings are not a satisfactory solution of the difficulty. Another way has been to put loose rings in recesses in the casing, and keep them close up to the bucket by screws adjustable from the outside.

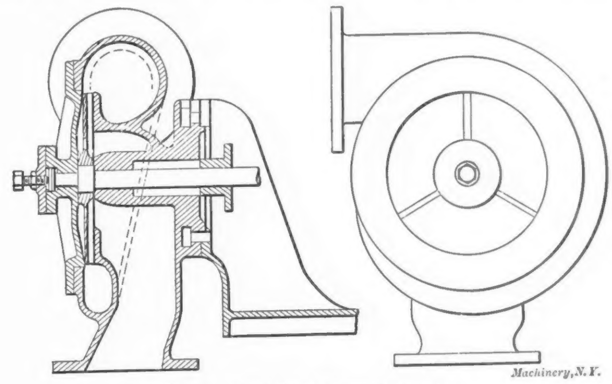


Fig. 5. Centrifugal Pump—Type D.

Pump Casings.

In Type A, which is the cheapest type of pump made, there is no attempt to reduce the velocity of the water leaving the bucket by means of an expanding chamber; and in many pumps the water emerges from the buckets only while passing the aperture of the outlet, so that, practically, the delivery from the bucket is intermittent, each section delivering for about a quarter revolution, and doing nothing for the remainder. Of course, the efficiency is comparatively low, and as it is only made in the smaller sizes and for low lifts, we need not waste any further time considering it. In Fig. 2, however, the conditions are more correctly allowed for, and it will be as economical as the other types, the flow of water from the bucket being similar to that in Type C.

In Type B, as the expanding chamber is formed partly around the outer circumference and partly between the sides of the bucket and the casing, and as the distance from the circumference of the bucket to the casing is comparatively short, the stream of water emerging from the bucket has to make a more or less sharp turn, as shown by dotted lines in the section, Fig. 3, to pass to the space on each side of the bucket.

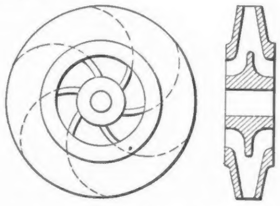


Fig. 6. Closed Type Bucket.

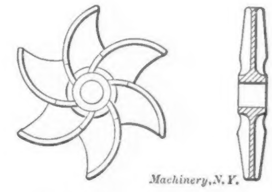


Fig. 7. Open Type Bucket.

Considering Type C, we find that the bucket is generally the open one, and the entry of the casing of the double inlet or balanced type. Referring to Fig. 4, the water in this case leaves the bucket and enters the expanding chamber in practically a circular plate of water of a width equal to the width of the periphery of the bucket, and moving radially or nearly so. As a rule this type of pump has the section of the expanding chamber circular and of increasing diameter, with practically sharp corners or of very small radius where the short, approximately parallel, passage known as the whirlpool chamber, from the pump bucket to the expanding cham-

ber, joins it. The dotted lines in Fig. 4 show the movement or the tendency of the movement of the water as it enters the expanding chamber. The natural tendency of the parallel moving sheet of water is to keep on in a straight line, and as it loses its velocity it spreads out and follows the path shown in dotted lines. This movement is modified to a certain extent by the water already in the chamber, moving toward the discharge. Attention to this movement of the water was first drawn from traces of deposits having been found in some casings at points *a* and *b*.

In Type D, Fig. 5, an attempt has been made to obviate some of these defects, and reduce the losses due to eddy. In this type it is noticed that the expansion chamber is formed, not in the center of discharge of the bucket, but to one side of it; the bucket is of the single inlet open type, tapered to the periphery to keep the velocity of the water constant. Referring to the section, Fig. 5, it will be noticed that as the water leaves the bucket it moves round the outside of the expanding chamber unbroken, and the water which has previously been discharged, and is moving toward the outlet, has a free passage through the middle of the chamber. The general result of this is that the water leaves the pump with a spiral movement of very long pitch. By using the single inlet there is no loss due to dividing the entering water. One bearing is provided close to the bucket, with another in the cover, both well protected from the water. Only one, and that the simplest form of joint, has to be broken to get at the bucket, and there is no difficulty whatever from end thrust with a properly designed bucket. The result of this type has been to get an increased efficiency of work, together with greater facility for examination. In every type of pump the casing should be provided with a stop which fits the bucket as closely as possible at the point marked *a* in Fig. 1 to cause the issuing water to move in one direction.

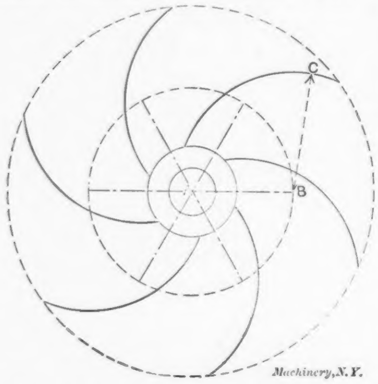


Fig. 8. Laying Out of the Vanes of the Bucket.

Compound Pumps.

In the compound or turbine pump we have the single centrifugal pump developed so as to obtain results which a single pump is not capable of, and results which at first sight would seem impossible to be obtained from a centrifugal pump at all. This has been accomplished by using two or more pumps working in series, that is with the delivery from the first passing to the second, the second to the third, and so on for as many series as are necessary for the head to be overcome. In compound pumps the conditions set up are somewhat different to those of the single pump. The guide plates for guiding the water on to the next bucket, so as to insure its moving in the right direction, are necessary, and these are fitted to all pumps, being arranged somewhat differently by each of the different makers.

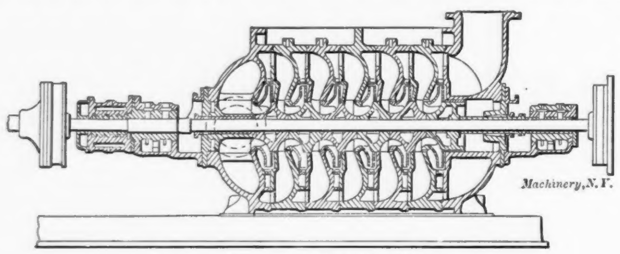


Fig. 9. Compound Centrifugal Pump.

It will be noticed in the sections of pumps given, that in Fig. 9 the closed bucket with single inlet is used, and is fitted with a balancing arrangement which is to balance the end thrust of successive buckets. Several makers have made their pumps with the buckets placed back to back, as in Fig. 10, to balance each other, but this necessitates more or less tortuous passages which should be avoided.

The compound pump may be roughly said to add a pressure for each successive stage equal to the pressure due to each stage if used as a single pump, that is, if with a single bucket pump one can get a pressure equivalent to 50 feet head, with two stages one would get 100, and with three stages 150 feet, and so on, and such pumps are made with 10 in the series, and up to very high lifts. The use of electric motors has given great impetus to the use of these high lift pumps and rendered possible their adoption where before they were impracticable, as driving these high lift pumps with either a belt or ropes is not at all a satisfactory way. With a compound pump one can also arrange to deliver a large quantity at a reduced pressure, or a small quantity at a higher pressure where the conditions require it, by running the buckets in parallel or in series.

In regard to efficiency of the compound pump, up to 75 and 80 per cent is claimed for it, except in very small sizes, and due to the fact that the delivery is constant and not intermittent, as with a reciprocating pump, the line of pipes can be made smaller for the same delivery, making a considerable saving in long lines of pipes, but the speed of flow should be considerably less than for single pumps. Also by driving them with motors they can be arranged to pump in stages, one compound delivering to the next stage, the second one receiving the delivery under a slight pressure, and so on for a considerable height, making them very suitable for deep mine pumping.

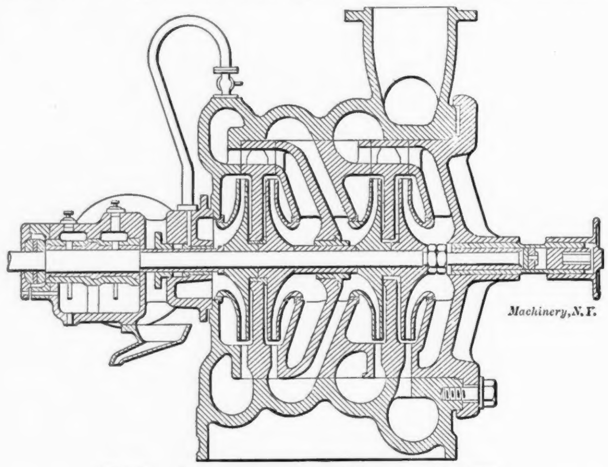


Fig. 10. Another Example of Compound Pump.

Losses of Energy.

In conclusion we may summarize the points where losses of energy in centrifugal pumps arise.

1. Friction of the water in the passages.
2. Loss of energy where water enters the bucket. This is practically a right-angle turn to the flow of the water, and unavoidable.
3. Loss of energy when water leaves the bucket and enters the expanding chamber.
4. Leakage at joint of bucket with casing.
5. Slip of bucket.
6. Friction of shaft in glands and bearings.

* * *

In this country we have made ourselves accustomed to look upon Hungary as being backward in all industrial progress. Recent reports, however, seem to indicate that this country is fairly well keeping pace with the progress in other parts of the world. The latest achievement in railroading in that country is the building of express locomotives for the government railroads of Hungary which will develop a speed of 85 miles an hour. In some other respects Hungary has also proven its ability to at least keep pace with the rest of us in industrial progress. It is claimed that the first subway in the world was constructed in Budapest.

* * *

The closing days of Congress were marked by an important amendment to the free alcohol bill which removes the present restrictions to small distillers, and makes it possible for farmers and others to establish small plants and produce denatured alcohol without a bonded warehouse. It undoubtedly will have an important influence on reducing the cost of denatured alcohol from the present price of 35 to 40 cents per gallon to a price that will make it an active competitor of gasoline and kerosene oil.

ON THE ART OF CUTTING METALS.—4.*

FRED. W. TAYLOR.

LIP AND CLEARANCE ANGLES OF TOOLS.

Contrary to the opinion of almost all novices in the art of cutting metals, the clearance angle and the back slope and side slope angles of a tool are by no means among the most important elements in the design of cutting tools, their effect for good or evil upon the cutting speed and even upon the pressure required to remove the chip being much less than is ordinarily attributed to them.

Clearance Angle of the Tool.

The following are our conclusions regarding the clearance angle of the tool:

(*a*) For standard shop tools to be ground by a trained grinder or on an automatic grinding machine, a clearance angle of 6 degrees should be used for all classes of roughing work.

(*b*) In shops in which each machinist grinds his own tools a clearance angle of from 9 degrees to 12 degrees should be used.

In seeking for the proper clearance angles for tools, we have as yet been unable to devise any type of experiment which would demonstrate in a clear cut manner which clearance angle is the best. The following, however, are the considerations which affect the choice of clearance angles.

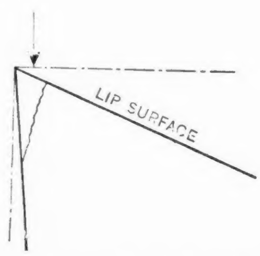


Fig. 28. Spalling of Tool-point by Downward Pressure of Chip.

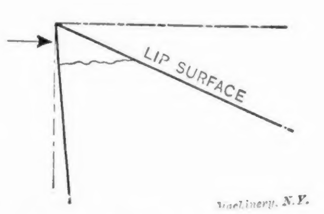


Fig. 29. Spalling of Tool-point by Pressure on Clearance Flank due to Feeding Tool into the Work.

On the one hand, it is evident that the larger the clearance angle, the greater will be the ease with which the tool can be fed (wedged or driven) into its work, the first action of the tool when brought into contact with the forging being that of forcing the line of the cutting edge into the material to be cut. On the other hand, every increase in the clearance angle takes off an equal amount from the lip angle, and therefore subjects the tool to a greater tendency to crumble or spall away at the cutting edge, as indicated in Figs. 28 and 29. It must be remembered also that the tool travels in a spiral path around the work, and that the angle of this path with a perpendicular line in the case of coarse feeds taken upon small diameters of work becomes of distinctly appreciable size. In all cases, therefore, the clearance angle adopted for standard shop tools must be sufficiently large to avoid all possibility from this source of rubbing the flank of the tool against the spiral flank of the forging. The clearance angles for roughing tools in common use vary between 4 degrees and 12 degrees. We have had experience on a large scale in different shops with tools carefully ground with clearance angles of 5 degrees, 6 degrees and 8 degrees. In the case of one large machine shop which had used clearance angles ground to 8 degrees through a term of years, they finally adopted the 6 degrees clearance angle with satisfaction. For many years past our experiments have all been made with the 6-degree clearance angle, and this has been demonstrated to be amply large for our various experiments. On the other hand, a 5-degree clearance angle in practical use in a large shop has appeared to us through long continued observation to grind away the flank of the tool just below the cutting edge rather more rapidly than the 6-degree angle. We have, therefore, adopted the 6-degree clearance angle as our standard.

It should be noted, however, that in shops systematized by us the cutting tools are invariably ground either on an automatic tool grinder, or by special men who are carefully taught the art of grinding and provided with suitable templets and gages, and that in this case the clearance angle for every tool is accurately made to 6 degrees.

In shops, however, in which each lathe or planer hand grinds his own tools, a larger clearance angle than 6 degrees should be used, say, an angle of from 9 degrees to 12 degrees, because in such shops, in nine cases out of ten, the workmen grind the clearance and lip angles of their tools without any gages, merely by looking at the tool and guessing at the proper angles; and much less harm will be done by grinding clearance angles considerably larger than 6 degrees than by getting them considerably smaller. It is for this reason that in most of the old style shops in which the details of shop practice are left to the judgment of the men or to the foreman, that clearance angles considerably larger than 6 degrees are generally adopted.

Lip Angle of the Tool.

The following are the conclusions arrived at regarding the angles at which tools should be ground:

A. For standard tools to be used in a machine shop for cutting metals of average quality: Tools for cutting cast iron and the harder steels, beginning with a low limit of hardness, of about carbon 0.45 per cent, say, with 100,000 pounds tensile strength and 18 per cent stretch, should be ground with a clearance angle of 6 degrees, back slope 8 degrees, and side slope 14 degrees, giving a lip angle of 68 degrees. These angles are used in the tool illustrated in Fig. 10, March issue.

B. For cutting steels softer than, say, carbon 0.45 per cent having about 100,000 pounds tensile strength and 18 per cent stretch, tools should be ground with a clearance angle of 6 degrees, back slope of 8 degrees, side slope of 22 degrees, giving a lip angle of 61 degrees. These angles are used in tool illustrated in Fig. 11, March issue.

C. For shops in which chilled iron is cut a lip angle of from 86 degrees to 90 degrees should be used.

D. In shops where work is mainly upon steel as hard or harder than tire steel, tools should be ground with a clearance angle of 6 degrees, back slope 5 degrees, side slope 9 degrees, giving a lip angle of 74 degrees.

E. In shops working mainly upon extremely soft steels, say, carbon 0.10 per cent to 0.15 per cent, it is probably economical to use tools with lip angles keener than 61 degrees.

F. The most important consideration in choosing the lip angle is to make it sufficiently blunt to avoid the danger of crumbling or spalling at the cutting edge.

G. Tools ground with a lip angle of about 54 degrees cut softer qualities of steel, and also cast iron, with the least pressure of the chip upon the tool. The pressure upon the tool, however, is not the most important consideration in selecting the lip angle.

H. In choosing between side slope and back slope in order to grind a sufficiently acute lip angle, the following considerations, given in the order of their importance, call for a steep side slope and are opposed to a steep back slope:

a. With side slope the tool can be ground many more times without weakening it.

b. The chip runs off sideways and does not strike the tool posts or clamps.

c. The pressure of the chip tends to deflect the tool to one side, and a steep side slope tends to correct this by bringing the resultant line of pressure within the base of the tool.

d. Easier to feed.

I. The following consideration calls for at least a certain amount of back slope. An absence of back slope tends to push the tool and the work apart, and therefore to cause a slightly irregular finish and a slight variation in the size of the work.

Before it is possible to discuss the proper lip angles for tools, two ways in which the cutting edge gives out should be described.

In Fig. 28 is shown on an enlarged scale the manner in which the sharp end of the wedge of the tool spalls off or crumbles away, when the lip surface of the tool right at the cutting edge is subjected to great pressure. In the case of cutting very hard metals and also in cutting all qualities of cast iron, the pressure of the chip is concentrated very close to the line of the cutting edge, and the harder the metal to be cut and the smaller its percentage of extension, the greater will be the concentration of the pressure close to this line, and the greater will be the tendency of the cutting edge to spall off or crumble away.

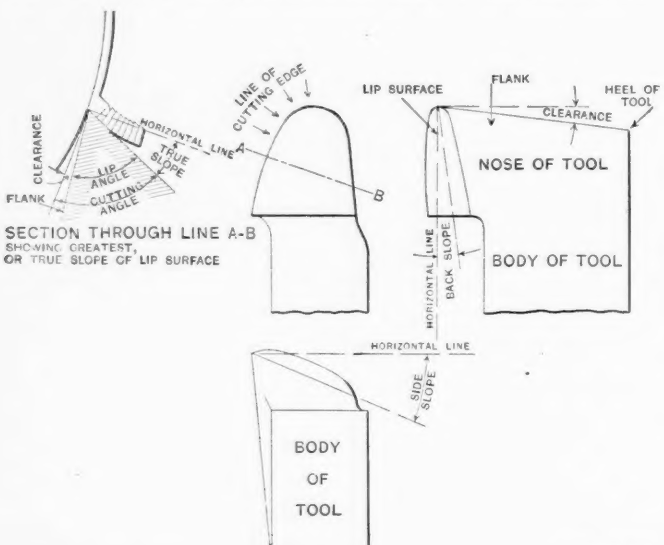
Fig. 29 shows another way in which the metal of the lip surface of the tool spalls off or crumbles away when the line of the cutting edge of the tool is subjected to great pressure in feeding or forcing the tool into the forging. In this case the hardness of the metal into which the tool is being fed

* Abstract of paper presented before the American Society of Mechanical Engineers, December, 1906.

is the chief element causing this type of injury to the cutting edge.

In deciding upon the acuteness of the lip angle of a tool, the absolute necessity of guarding against the spalling or crumbling of the cutting edge from both of the foregoing causes becomes by far the most important of all considerations. In this connection the essential fact to be borne in mind is that the harder the metal to be cut, the blunter must be the lip angle of the tool. In the case of chilled iron and semi-hardened steel, for instance, the lip angle must be made from 86 degrees to 90 degrees. A smaller angle than this will cause the metal at the extreme cutting edge to spall off or crumble away (quite as much on account of the feeding pressure as from the pressure of the chip), and thus ruin the tool. As the metal to be cut grows softer, however, the lip angle can be made keener without danger of spalling, until with standard tools intended to cut the softer steels, say with a high limit for hardness of about 100,000 pounds tensile strength and 14 per cent to 18 per cent stretch, the smallest lip angle which, in our judgment, it is on the whole wise to use would seem to be about 61 degrees.

Dr. Nicolson with his dynamometer experiments has shown that with a "cutting angle" of 60 degrees, corresponding to a lip angle of 54 degrees, clearance angle 6 degrees, tools re-



Machinery, N.Y.

Fig. 30. Illustrating the Terms Body, Nose, Flank, Heel, Lip Surface, Clearance Angle, Back Slope, Side Slope, True Slope, Lip Angle, Cutting Angle, and Line of Cutting Edge.

move metal with the minimum of pressure. This is also corroborated in a general way by our observations in cutting dead soft steel. Therefore from the standpoint of pressure, with a view to taking the largest cut with a given pulling power and with the least strain upon the working parts of the lathe, this angle should be approached. And although, on the whole, the question of pressure on the tool has less weight than either the crumbling at the cutting edge, the cutting speed, or the proper angles for obtaining the longest life and the largest number of grindings for a given tool, still it must be considered; and it is this which has led us to choose for our standard in each case *the keenest cutting angle which is free from danger of spalling.*

Metals which even approach in hardness chilled iron and semi-hardened steel are but seldom met with in ordinary shop practice and, therefore, in selecting the lip angles for standard shop tools, we have divided the metals to be cut in a shop into two classes:

a. Cast iron and the harder classes of steel, say, beginning as a low limit for hardness with a steel of about 0.45 to 0.50 per cent carbon, 100,000 pounds tensile strength and 18 per cent stretch; and

b. The softer classes of steel.

Our guiding principle in selecting the lip angles for the tools to be used in cutting cast iron and the harder classes of steel has been to select what we believe to be the smallest or most acute lip angle which can be safely depended upon to run without danger of spalling off at the cutting edge while cutting the harder steels ordinarily met with in machine shop practice (such as the hardest steels used in this country for car wheel tires, say of 135,000 to 140,000 pounds tensile strength, and 9 to 10 per cent of stretch, and, for instance, unannealed tool steels, or the harder of the oil hardened and annealed forgings which are used under government specifications for making large steel cannon, etc.); and after large experience in cutting metals of this quality we have concluded that it would be unsafe to use a more acute lip angle than that shown in Fig. 10, namely, a lip angle of 68 degrees, with clearance angle of 6 degrees, side slope of 14 degrees and back slope of 8 degrees. We have demonstrated by repeated trials that tools with the above lip angle are safe from danger of spalling or of crumbling at the cutting edge, even when cutting tire steel, gun steel or tool steel.

For shops which are engaged mainly in cutting steels as hard as tire steel, we should recommend as a standard tool one having 6 degrees clearance, 5 degrees back slope and 9 degrees side slope, giving a lip angle of 74 degrees. Since for this special work the tools can be run at a high cutting speed, they can be ground in less time, and they can be ground more times for each dressing in the smith shop, than tools with more acute lip angles.

Repeated trials were made with tools ground first with a clearance angle of 6 degrees, back slope of 5 degrees, and side slope of 9 degrees, giving a lip angle of 74 degrees, and afterwards with a clearance angle of 6 degrees, back slope of 8 degrees, and side slope of 14 degrees, giving a lip angle of 68 degrees. No difference was indicated in the cutting speed of these two tools when used upon a very hard forging.

It is interesting, however, to note that machinists who grind their own tools and who are accustomed to machining hard tires and metals of the classes above referred to, invariably use a blunter lip angle than our standard of 68 degress. After making a few mistakes by grinding tools with lip angles which are too acute, they are sure to lean too far toward the safe side, and adopt lip angles which are not quite sharp enough. They are influenced in this very largely, however, by the fact that the less acute the lip angle, the easier it is and the less time it requires to grind a tool. A tool with a lip angle of 80 degrees for example, can be more easily ground than one with a lip angle of 70 degrees.

In those shops which work upon metals of average hardness and in which the tools are furnished to the machinists ground to the required shapes, and in which either automatic tool grinders are used or special grindstone men are employed to grind the tools, more work can be gotten out by grinding the tools to angles at least closely approximating ours than from the use of tools with blunter lip angles.

The reason for preferring the more acute lip angle of 68 degrees, for cutting medium hard metals to the angle of 75 degrees to 85 degrees adopted by the average machinist, is that the more acute angle removes the metal with a lower pressure on the tool; while repeated experiments made by us in cutting medium hard steels indicate that there is little if any difference in cutting speed between the 68-degree lip angle and coarser angles. Our standard tools, therefore, are capable of taking heavier cuts than the blunter tools, and in a given machine working to the limit of its pulling power, can remove rather more metal in a given time.

FORGING AND GRINDING TOOLS.

On the Shape of Tools as Affected by Grinding and Forging.

The following are the important conclusions arrived at upon this subject:

A. The shapes into which tools are dressed and the ordinary methods of dressing them are highly uneconomical, mainly because they can be ground only a few times before requiring redressing.

B. The tool steel from which the tool is to be forged should be one and one-half times as deep as it is wide.

C. To avoid the tendency of the tool to upset in the tool post under pressure of the cut, the cutting edge and the nose of the tool should be set well over to one side of the tool.

D. Tool builders should design lathes, boring mills, etc., with their tool-posts set down lower than is customary below the center of the work.

E. In choosing the shape for dressing a tool, that shape should be given the preference in which the largest amount of work can be done for the smallest combined cost of forging and grinding.

F. Forging is much more expensive than grinding; therefore the tool should be designed so that it can be ground:

a. The greatest number of times with a single dressing; and

b. With the smallest cost each time it is ground.

G. Best method of dressing a tool is to turn its end up high above the body of the tool. Tools can be entirely dressed by this means in two heats.

H. Importance of carefully heating the tool for dressing.

J. Fire or heat cracks in tools are due to the following causes:

a. Seams or internal cracks in bar of tool steel.

b. Nicking and breaking the bar of tool steel while it is cold.

c. Failing to turn the tool over and over while heating it for forging.

d. Too rapid heating, particularly at the start, in a hot fire.

K. It is of great importance to properly adjust the relative amount of work to be done in the smith shop and on the grinding machine in making the tool.

a. Too much work is generally done in dressing tools to exact shape in the smith shop, particularly when automatic grinding machines are used.

b. A limit gage should be used by the smith to properly regulate the proportion of smith work and grinding work in making the tool.

On Grinding Tools.

The following are the important conclusions arrived at with reference to grinding tools:

A. More tools are ruined in every machine shop ***through overheating in grinding*** than from any other cause.

B. The most important consideration is how to grind tools rapidly without overheating them.

C. To avoid overheating, a stream of water amounting to five gallons per minute should be thrown, preferably at a slow velocity, directly on the nose of the tool where it is in contact with the emery wheel.

D. To avoid overheating where tools are ground by hand or with an automatic tool grinder, the surface of the tool should never be allowed to fit closely against the surface of the grindstone. To prevent this, tools should be constantly moved or wobbled about during the operation of grinding.

E. To lessen the danger of overheating on the emery wheel and to promote rapid grinding, tools should be dressed so as to leave the smith shop with a clearance angle of about 20 degrees, while 6 degrees only is needed for cutting.

F. Flat surfaces upon tools tend far more than curved surfaces to heat tools in grinding.

G. Tools with keen lip angles, (*i. e., steel side slopes*) are much more expensive to grind than blunt lip angles.

H. It is economical to use an automatic tool grinding machine even in a small shop.

J. There is little economy in an automatic grinder for any shop unless standard shapes have been adopted for tools, and a large supply of tools is kept always on hand in a first-class tool room so that tools of exactly the same shape can be ground in quite large batches or lots.

K. Corundum wheels made of a mixture of grit size No. 24 and size No. 30, are the most satisfactory for grinding ordinary shop tools.

L. In grinding flat surfaces skillful hand grinders invariably keep the tool wobbling about on the face of the grindstone in order to avoid heating.

On the Size and Proportion of the Body of the Tool.

Twenty-five years ago it was perhaps the more general practice in this country to make the cross-section of the body of lathe and planer tools square, and this practice still generally prevails in England and upon the Continent. In fact, in the report of the Manchester experiments, previously referred to, in which the tools of eight of the leading engineering establishments were placed in competition, all of the tools illustrated have square shanks. Mr. James M. Gledhill also, in his admirable paper, on "The Development and Use of High Speed Tool Steel," read before the Iron and Steel Institute in 1904, refers to tools with square shanks as being the standard in use in the works of Armstrong, Whitworth & Co. It may be said, however, that the more general practice in this country at the present time is to make the depth of the body of the tool considerably greater than its width.

In choosing the proportion of the height of the shank to its depth, the effect of two forces must be considered—the downward pressure upon the nose of the tool, due to cutting the chip; and the side pressure at right angles to the tool, due partly to the feeding resistance, and partly to the direction in which the chip moves across the lip surface.

Dr. Nicolson, in his experiments, has shown that in the great majority of cases the side pressure upon the tool does not exceed 20 per cent of the downward pressure; and that more frequently the side pressure is even a smaller percentage of the vertical pressure. On the other hand, tools when properly designed and properly placed in the tool-post are supported in the majority of cases almost directly beneath the cutting edge, thus directly resisting the downward pressure upon the tool, and placing it mainly under compression, and so greatly diminishing the heavy downward transverse bending and breaking strains. If, then, tools were always set in their most advantageous position in the tool-post, the practice of using steel of square cross-section might not be far wrong. However, in both lathe and planer work it is often necessary to set the tool with considerable overhang beyond the tool support, and in these instances it is evident that the depth of the tool should be considerably in excess of the width.

It is manifestly of great importance to have the tools as light as possible, consistent with their strength, for ease of handling in setting the tool in and removing it from its tool-post, and in grinding and dressing; and a much lighter tool of equal strength and stiffness can be used when the height exceeds the width than when the cross-section is square.

For the above reasons some of the large machine shops in this country have adopted a proportion of 2 in height to 1 in width for the cross-section of their standard tools. However, owing to the desirability of turning the noses of tools high above the top surface of the body of the tool for economy in grinding and dressing, and also owing to the design of the tool-posts of the greater part of the machines in this country, it is, in the judgment of the writer, unwise to adopt a height as great as 2 to 1 for the body of the tool. After practical trial on a large scale and close observation of several different proportions, we have adopted as standard the section of 1½ in height to 1 in width for the body of the tool.

Importance of Lowering Tool Supports in Designing Machine Tools.

We attach so much importance to raising the nose of the tool above its top surface and at the same time having the section of the body of the tool deeper than its width, that we would especially call the attention of machine tool builders to the desirability of designing their tool supports in lathes, boring mills, etc., further below the centers than is customary. When preparing for the best shop standards in reorganizing the management of machine shops, it has become our custom to systematically go over all of the machine tools and lower the tool rests to as great an extent as is practicable. Fortunately this in many cases entails but a small expense. However, in other cases it has been found desirable and economical to re-design the cross slides of many lathes so as to accomplish this object.

The Length of the Shanks of Cutting Tools.

In choosing the proper lengths for cutting tools, we again find two conflicting considerations:

A. It requires a certain very considerable length for the shank of each sized tool in order to fasten or clamp it in its tool-post. When the tool becomes shorter than this minimum, it must be thrown away, thus wasting costly metal, particularly in the case of the modern high-speed tools.

B. On the other hand, the longer the body of the tool, the more awkward and the slower become all of the operations in handling the tool, beginning with the dressing and followed by the grinding, storing, handling in the tool room, and setting and adjusting in the machine.

We know of no definite, clear cut method of comparing the relative loss in handling long and heavy tools with that of the waste of the tool steel, so that the adoption of standard lengths for dressing tools of various sizes has been largely a matter of "rule of thumb" judgment on our part, and the length of tools which we have adopted, corresponding to different sized bodies, is given in the table below.

Let width of shank of tool $= A$, and length of tool $= L$; then $L = 14A + 4$ inches.

Size of Shank of Tool, inches.	Length of Tool, inches.	Size of Shank of Tool, inches.	Length of Tool, inches.	Size of Shank of Tool, inches.	Length of Tool, inches.
½ x ¾	11	⅞ x 1⅜	16¼	1½ x 2¼	25
⅝ x 1	12¾	1 x 1½	18	1¾ x 2⅝	28½
¾ x 1¼	14½	1¼ x 1⅞	21½	2 x 3	32

VOLUME, PRESSURE AND HORSEPOWER OF BLOWER PERFORMANCE.

The following data, diagrams and tables (see supplement) compiled by the B. F. Sturtevant Co. appertain to the measurement of volume, pressure and horsepower of blowers at pressures 1 to 10 pounds per square inch. A table of diameters of cupola blast pipes for lengths 20 to 140 feet, and losses of ¼ and ½ ounce pressure per square inch is also included. The friction varies as the square of the velocity and inversely as the diameter of the pipe, therefore, if the diameter of the pipe is doubled the friction loss is divided by 32, provided, of course, the same volume is carried. The advisability of using a large pipe for conveying the air is clearly shown.

Velocity.—The volume of air discharged from an orifice or pipe is, theoretically, equal to the product of the velocity of the air flowing and the area of the orifice. Hence, for the calculation of volume, the velocity is an important factor. To determine the velocity, the Pitot tube is commonly used as shown in the accompanying illustration. It should be inserted in the center of a straight run of blast pipe within about ten feet of the blower. One part of the Pitot tube transmits the total pressure, which is the sum of the static pressure and the velocity pressure. The other part, in communication with the slots shown by dotted lines in Fig. 2, transmits the static pressure. Evidently the difference is the velocity pressure. Each is connected to a water gage which should show magnified readings so that the difference may be accurately determined.

Accuracy.—Great care should be exercised in measuring the velocity pressure, and the instruments should be carefully calibrated. In the ordinary blast pipe for conducting air from the blower to the cupola or furnace, the velocity should not exceed two or three thousand feet per minute. As this velocity corresponds to a pressure of only about 0.4 inch of water, the measurement requires care, but with good instruments the readings will be accurate enough for all practical purposes.

Volume.—The velocity pressure being known, the volume of free air passing through the pipe may be determined from the following formula:

$$V = a\,v = \frac{60\,a\,c\,P_1}{P}\sqrt{\frac{2\,g\,p}{d}}$$

in which V = the volume of free air in cubic feet per minute,

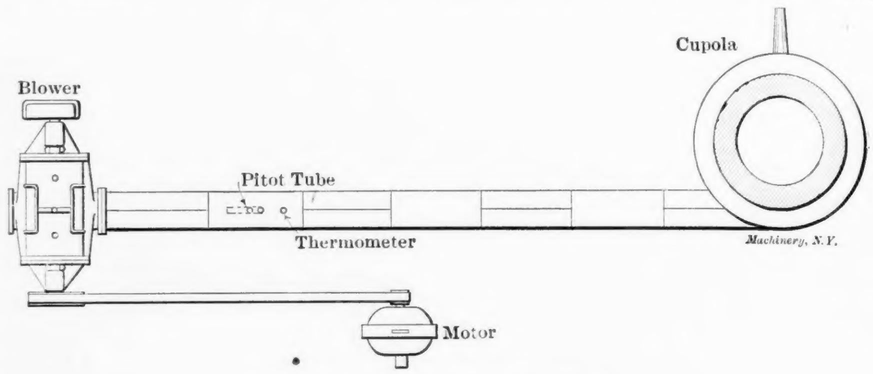


Fig. 1. Location of Pitot Tube in Blast Pipe.

c = coefficient of Pitot tube, which should be determined for each tube,
a = area of the pipe in square feet,
v = velocity in feet per minute,
$2g$ = 64.32,
p = velocity pressure in pounds per square foot; p is the difference between the two pressures observed on the Pitot tube.
d = density or weight per cubic foot of air at pressure, temperature and humidity at point of observation,
P_1 = absolute pressure of air in the pipe in pounds per square foot,
P = atmospheric pressure in pounds per square foot.

Horsepower.—Assuming that the air is compressed without cooling, the horsepower may be found from the following:

$$H.P. = \frac{V\,P\left[\left(\frac{P_1}{P}\right)^{\frac{1}{4}} - 1\right]}{11{,}000}$$

in which
V = volume of free air in cubic feet per minute, as found above,
P = pressure of the atmosphere or suction pressure (absolute) in pounds per square foot,
P_1 = pressure of compression (absolute) in pounds per square foot.

There are, however, including the preceding one, four formulas which may be used in computing the horsepower required. These are given in the supplement.

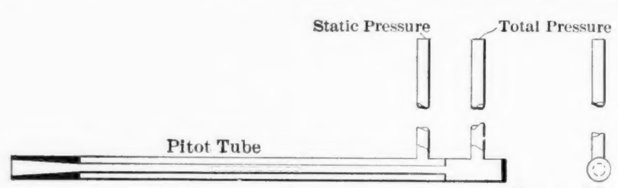


Fig. 2. Construction of Pitot Tubes.

The formula No. 1 is used when the air is cooled during compression, as in ordinary air compressors; No. 2 when it may be assumed that the air is compressed so quickly that it does not have time to cool to atmospheric temperature; No. 3 is the ordinary "hydraulic" formula, and No. 4 is used for positive or rotary blowers.

DIAMETERS OF BLAST PIPES.

Tons of Iron per Hour	Inside Dia. of Cupola Inches	Cubic Ft of Air per Minute	Length of Pipe in Feet — Diameter of Pipe with Drop of: 20		40		60		80		100		120		140	
			¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.	¼ oz.	½ oz.
1	23	500	6	5	7	6	7	6	8	7	9	8	9	8	9	8
2	27	1,000	8	7	9	8	10	9	11	9	11	10	12	11	12	11
3	30	1,500	10	8	11	10	11	10	12	11	13	11	13	12	14	12
4	32	2,000	11	9	12	11	13	12	14	12	15	13	15	14	16	14
5	36	2,500	12	10	14	12	15	13	15	14	16	14	17	15	17	15
6	39	3,000	13	11	15	13	16	14	17	15	18	15	18	16	18	16
7	42	3.500	13	12	15	13	17	15	17	15	18	16	19	17	20	18
8	45	4,000	15	12	16	15	18	15	18	16	19	17	20	18	21	18
9	48	4.500	15	13	17	15	18	16	19	17	20	18	21	19	22	19
10	54	5,000	15	13	18	15	19	17	20	18	21	18	22	19	23	20
11	54	5.500	16	14	18	16	20	17	21	18	22	19	23	20	23	20
12	60	6,000	17	14	19	17	20	17	21	19	22	20	23	21	24	21
13	60	6,500	17	14	19	17	21	18	23	19	23	20	24	21	25	22
14	60	7,000	18	15	20	18	22	19	23	20	24	21	25	22	26	23
15	66	7,500	18	16	21	18	22	19	24	21	25	22	26	22	27	23
16	66	8,000	18	16	22	18	23	20	24	22	26	22	26	23	27	24
17	66	8,500	18	16	22	18	23	20	24	22	26	22	27	24	28	24
18	72	9,000	18	17	22	18	24	21	25	22	27	23	27	24	28	25
19	72	9,500	20	17	23	20	24	22	26	23	28	23	28	25	29	26
20	72	10,000	20	18	23	20	25	22	27	23	28	24	29	25	30	26
21	78	10,500	21	18	24	21	26	23	27	23	29	25	30	26	30	26
22	78	11.000	21	18	24	21	27	23	28	24	29	26	30	27	31	27
23	78	11.500	21	19	25	21	27	24	28	25	30	26	30	27	31	27
24	84	12 000	22	19	25	22	28	24	28	25	31	26	31	27	32	28
25	84	12.500	22	19	26	22	28	24	29	26	31	27	32	28	33	28
26	84	13.000	22	19	26	22	28	24	29	26	31	27	32	28	33	28
27	90	13.500	23	20	26	23	28	24	30	26	31	27	32	28	34	28
28	90	14,000	23	20	27	23	29	25	30	27	32	28	33	29	34	29
29	90	14,500	23	20	27	23	29	26	31	27	32	28	33	29	34	30
30	90	15.000	24	21	27	24	29	26	31	27	32	28	34	30	35	30

The minimum radius of each turn should be equal to the diameter of the pipe. For each turn thus made add three feet in length, when using this table. If the turns are of less radius, the length added should be increased proportionately.

PNEUMATIC CLAMP DRILLING JIG.

O. C. BORNHOLT.

The accompanying line cuts, Figs. 1 and 4, and the halftones, Figs. 2 and 3, show a pneumatic clamp drilling jig which was designed for holding small castings, pinions, spur gears, sprockets, pulleys, etc., for reaming or drilling. This type of jig is used with great success in one of the largest manufacturing concerns in Chicago. Formerly castings of the nature named were held in a jig, using a screw bushing mounted in a swinging arm to hold the work while drilling; the arm was swung around over the casting and the bushing was screwed down onto the work. Frequently the operator would neglect to screw the bushing down tightly against the work, with the resultant of a bad job of drilling and a spoiled piece. In any case there was considerable time lost in operating the jig.

The air clamping drilling jig shown in section in Fig. 1 was designed to decrease the time required to operate the jig and to improve the character of the work done. The cut shows how a bevel gear is held. The gear rests on the inclined face *C*, and between three chuck jaws. Beneath the casting is a ring, *A*, having three cam eccentric slots which move the jaws *B* toward or away from the center when the ring is turned by a suitable handle. With this jig the operator needs only to turn an air valve handle to hold the work securely and in the central position. To hold spur gears a centering piece is used, similar to the one shown for bevel gears in Fig. 1, with the exception that the surface *C* is made flat, the jaws then being used alone to center the work.

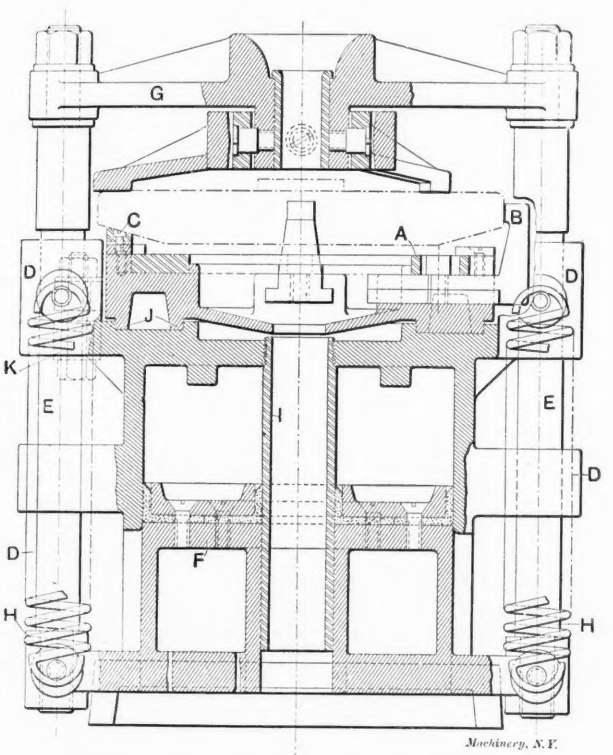


Fig. 1. Vertical Section, Pneumatic Clamping Jig for Work on Agricultural Machinery.

The jig includes a cylinder having two lugs or ears *D* which encircle the guides *E*. These guides connect the piston *F* with the cross-arm or yoke *G*, which holds the drill bushing. The admission of air to the cylinder forces the yoke and bushing down on the work and holds it there until the piece is finished. The air is then released and the tension springs *H*, of which four are provided, pull the piston and connected cross-arm up and release the work. Compressed air is admitted in the side of the cylinder through a pipe in which is fitted an ordinary three-way valve. The pipe *I* in the center of the cylinder is an important feature, as it permits chips to fall through the jig at the bottom instead of collecting on the top. What few chips accumulate on the top are removed by a hose leading from the exhaust port of the valve and directed against the top of the cylinder, thereby blowing the chips away with each exhaust. The centering device is made different, of course, for different pieces, Fig. 1 showing one for a "flat" bevel gear, and each pattern of pinion, gear or sprocket has to have a corresponding piece *C*. The cylinder has an annular groove *J* turned in the top and made concentric with the axis of the cylinder and of the drill jig. The centering device has two projections which fit the cylinder top

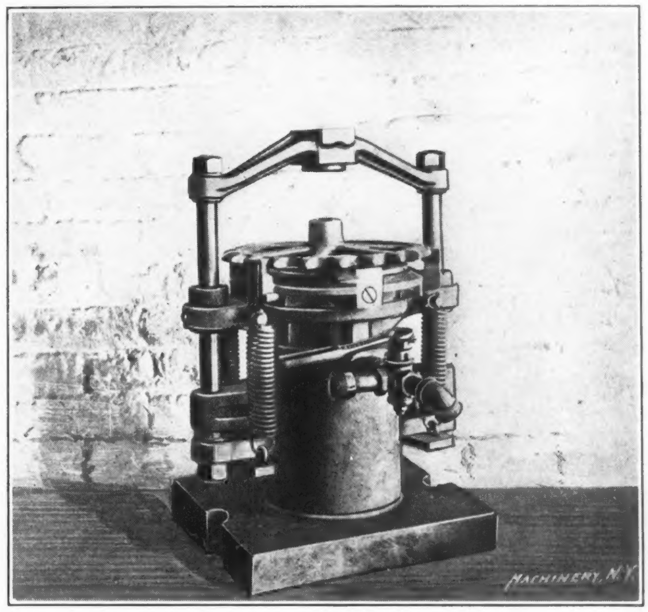


Fig. 2. Pneumatic Clamping Jig for Sprocket Wheel.

and groove. This makes the air cylinder conveniently interchangeable with any number of centering devices, the centering device being removed quickly so that there is little time lost in making changes, the clamping being a simple matter. The cylinder has three lugs *K* with open slots for bolts, these matching with three lugs on the centering device and constituting the clamping arrangement for the centering piece. When the centering piece is to be changed the three bolts are loosened, slipped out of the slots, and the centering piece is lifted out and exchanged for another.

If the drill bushing has to be changed, the yoke *G* is taken off and replaced by another, for it is generally desirable to have a yoke with its own bushing for each job. With small work the yoke simply has a bushing driven from the bottom,

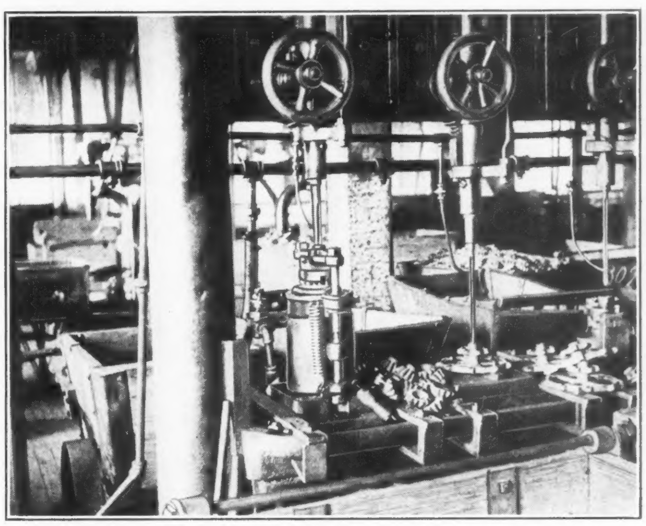


Fig. 3. Clamping Jig in Use, with Pinion Centering Device.

as illustrated in the halftone Fig. 2, and the bushing alone presses against the work, but for larger work, which should be held down at three places on the rim, the yoke and clamp are connected with a universal joint as illustrated in Fig. 1, thus insuring equal pressure on the three clamping points.

Fig. 3 shows a small pneumatic jig fitted up for drilling small bevel pinions. There is a tapered cup on the cylinder and one on the yoke. The taper on the lower cup is identical with the taper of the tooth of the bevel pinion to be drilled.

Fig. 4 is a centering device, used on the air cylinder, in which there is a float. This float rests on a heavy spring and on the float are three lugs *A* which support the gear casting. This device centers the casting while the yoke is pulled down by air pressure until the gear rests on the three stationary surfaces *B*. The yoke with its equalizing saddle *C* holds the bevel gear firmly while drilling.

GRINDING A LARGE CRANKSHAFT.

J. C. SPENCE.

A prominent English chainmaker recently sent to the Norton Grinding Co., Worcester, Mass., a rough-turned crankshaft to be ground to the dimensions given in Fig. 1. The conditions given were that the throw must be ½ inch plus or minus 0.001 inch and that the keyway shown in Fig. 1

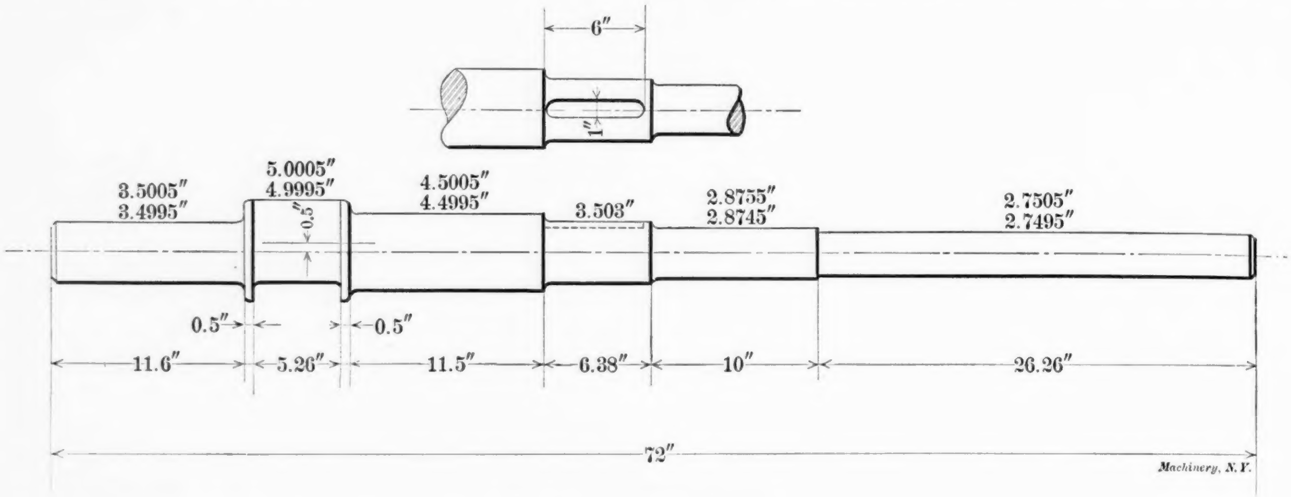


Fig. 1. Crankshaft to be Ground.

should line up exactly with the highest point of the eccentric. The keyway was already in the shaft, when received. The following method was pursued in preparing the crankshaft for the grinder:

Two cast iron blocks, Fig. 2, were planed to the dimensions given and one side, *E* in Fig. 3, was scraped to a surface-plate. A squaring chip was then taken across a lathe face-plate and the plate was rigged with blocks and parallels

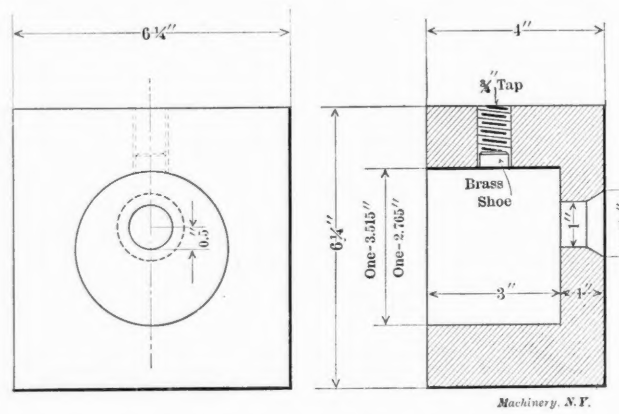


Fig. 2. Fixture for Grinding Crankshaft.

as per Fig. 3. The surface *E* of the parallel *B* was also scraped to a surface-plate.

When the large hole was bored, the block *A*, Fig. 3, was against parallel *C* and when the small hole, or eccentric hole, was bored, *A* was moved along parallel *B* and block *D* was inserted. Tissue paper was used in both settings to insure actual contact.

The large holes were bored 0.015 inch larger than the finished diameter of the crankshaft ends. After boring the small holes, a 1-inch arbor was forced into the small holes and the 60-degree center holes were turned with a lathe tool. The truth of these 60-degree holes was tested by means of a ground cone point and red lead. A tapped hole and setscrew completed each block.

The shaft was now prepared for the blocks by grinding each end a wringing fit for its block. Before doing this, the center holes in the shaft were tested and scraped to a 60-degree cone point, to insure a perfectly round shaft when ground.

The next operation was to correctly locate the keyway. For this, two blocks, *A* and *B*, Fig. 4, were made. *A* is a 1-inch block that tapped lightly into the keyway and projected a short distance, as shown. *B* is a block planed to micrometer

ALCOHOL AND CALCIUM CARBIDE CARBURETER.

An alcohol and calcium carbide carbureter was the subject of an interesting demonstration made by Joseph Tracy in New York recently, its object being to demonstrate the possibilities of a new fuel mixture for gas engines having denatured alcohol and acetylene gases as its components. Mr. Tracy is a racing automobilist of considerable reputation and is greatly interested in the future of denatured alcohol. He made a trip from New York to Philadelphia January 1 in an automobile equipped with an ordinary gasoline engine, using denatured alcohol as the fuel. The experience of this trip demonstrated that while alcohol could be used in ordinary gasoline engines it had some drawbacks that made changes necessary. The subject of the demonstration was an engine fitted with a special carbureter in which a small quantity of calcium carbide is placed and is wetted with a mixture of alcohol and water in the proportion of one-sixth water to five-sixths pure alcohol. The alcohol is thus drawn through a bed of calcium carbide producing a mixture of alcohol and acetylene

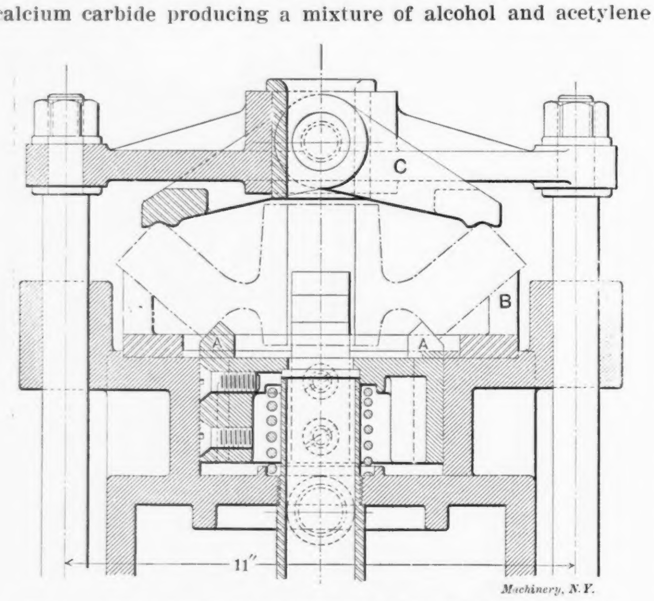


Fig. 4. Vertical Section of Jig Fitted with Equalizing Centering Device.

gas which has been named "alkoethine." The advantage claimed for the mixture is that it increases the rapidity of action, producing about the same result as gasoline but at a lower cost. It is asserted that the combination of the alcohol and acetylene gases makes a fuel that partakes of both the merits of alcohol and acetylene gases and at a cheaper price than is possible with gasoline or denatured alcohol alone.

gage, and of such a height as to bring the center line of the keyway and the center line of the crankshaft into a plane parallel to the planer surface *C*, Fig. 4. The proper height of *B* was easily found by means of micrometer measurements and deductions.

Having made *A* and *B*, Fig. 4, the whole job was taken to a newly planed planer table and the end blocks were placed on the crankshaft. *A* was then placed in the keyway and the crankshaft turned until *A* rested on *B*. With tissue paper

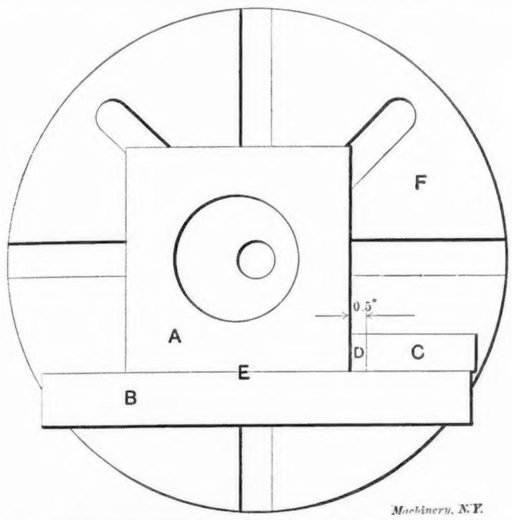


Fig. 3. Method of Boring Fixture for Grinding Crankshaft.

under the end blocks *D*, Fig. 4, and between *A* and *B*, adjustments were made until all the papers held fast. The blocks *D* were then made secure by means of the setscrews *E*. After a final test with the tissue papers, the crankshaft was ready to have the eccentric ground. This was done on an 18-inch by 96-inch Norton plain grinder. The fillets on the eccentric were also ground at the same time.

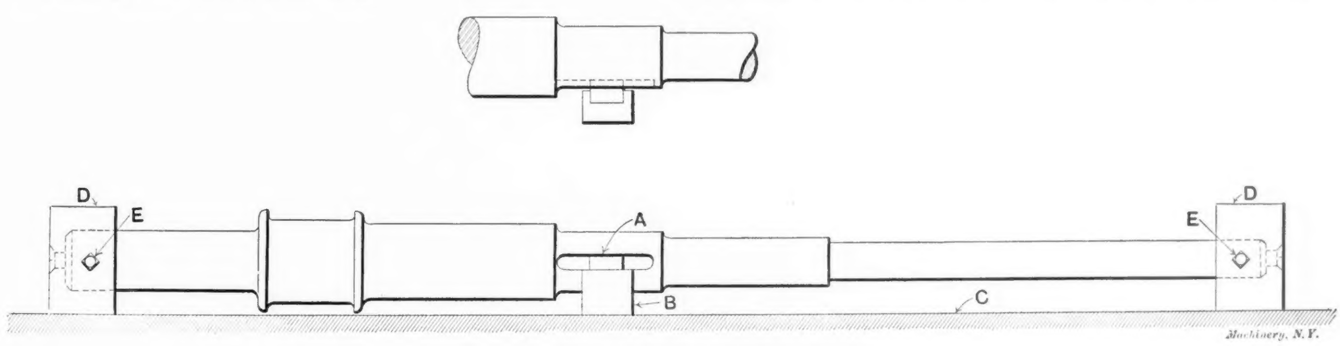


Fig. 4. Method of Mounting Crankshaft in Fixture.

The length of throw was tested in the grinder by means of a Bath indicator and a 1-inch B. & S. disk, and found to be within the required limits.

When the eccentric was completed, the end blocks were removed and the remainder of the crankshaft was ground on its own centers.

* * *

According to the *Iron Age* a new tunnel is to be built through the Bernese Alps for a railroad to connect at Brigue with the Simplon tunnel route. The new road will be 35 miles long and the tunnel 8.39 miles. The road will be operated by electricity, and have a maximum gradient of 0.27 per cent. This road will be the shortest route between Milan and Genoa and the north and northwest of Switzerland. It will shorten the approach to the Simplon tunnel, and will compete with the St. Gotthard tunnel route. The distance between the Italian cities mentioned and Paris will in fact be 15 miles shorter than at present, and 100 miles nearer than by the St. Gotthard tunnel. The new road is expected to be of great value to central Switzerland, particularly to the canton and city of Berne. Work on the tunnel is to be commenced at once, and the approaches and connections will be completed later, when progress on the tunnel boring is sufficiently far advanced to require it. This will be the fourth Alpine tunnel exceeding 8 miles in length.

CAM CURVES.

ARTHUR B. BABBITT.

When the curve of a cam is not determined by a given definite motion of the follower, and the condition presented to the designer is simply to make the follower move through a given distance during a given angle of motion of the camshaft, the ease and silence with which the cam works depends upon the character of curve used in laying out the advance and return. The uniform motion curve, the simplest of all curves to lay out, is a hard-working curve, and one that can-

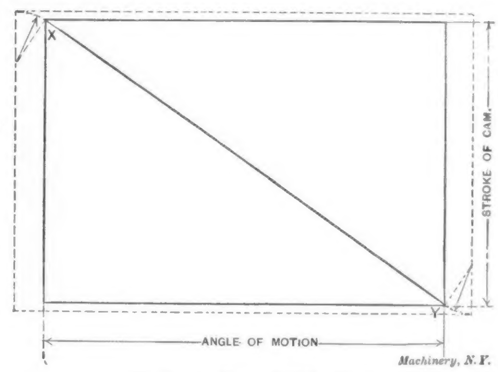


Fig. 1. Uniform Motion Curve.

not be run at any great speed without a perceptible shock at the beginning and end of the stroke.

The uniform motion curve would be represented in a diagram by the diagonal of the rectangle of which the base represents the angle of motion, and the altitude, the stroke of the cam, as shown by the full lines in Fig. 1. However, should the nature of the design demand a uniform motion for a given part of the revolution of the camshaft, the shock at beginning and end of stroke may be modified by increasing both the angle of motion and the stroke, and, in the diagram, filling in arcs of circles as shown by the dotted lines in Fig. 1. The amount of curvature at the ends of stroke is dependent upon the amount it is possible to increase the angle of motion, and the centers of the arcs are determined by drawing perpendiculars to *X Y* as shown in Fig. 1. It will be noticed that the uniform motion has been maintained for the original angle, the modifications at the ends causing the increase of angle of motion and of stroke, the rectangle formed by these two being shown by dotted lines. Even with these modifications the cam is still apt to work hard, especially if the angle of motion is small.

The crank or harmonic motion curve works much more easily than the uniform curve, and a cam laid out with this motion may be run at a high speed without much shock or noise. To draw a diagram of this curve, draw a semi-circle having a diameter equal to the stroke of the cam, and divide this semi-circle and the line representing the angle of motion into the same number of equal parts. The intersection of lines drawn from these divisions will give points on the curve. Fig. 2 shows the harmonic curve and the manner in which it is obtained.

Probably the easiest working cam curve is the one known as the gravity curve. This curve has a constant acceleration or retardation bearing the same ratio to the speed as the acceleration or retardation produced by gravity; hence its

name. A body falling from rest will pass through about sixteen feet in one second (more accurately 16.09 feet). During the next second the body will increase its velocity by about thirty-two feet, making the distance covered during the second second forty-eight feet; during each succeeding second the body will gain in velocity thirty-two feet. Using sixteen feet as a unit of measurement, it will be seen that a body would travel through units 1, 3, 5, 7, 9, etc., during successive seconds or units of time. To apply this motion to the cam curve we might divide the angle of motion into a given number of equal parts and, using the units given above, we may increase the velocity to a given maximum and then, retarding with the same ratio, bring the follower again to rest at the other end of the stroke. In the diagram, Fig. 3, the line representing the angle of motion is divided into eleven equal parts which necessitates eleven divisions on the line representing the stroke of the cam. If the motion for the first part of the stroke is to have a constant acceleration, as referred to above, the distance traversed by the follower during the first

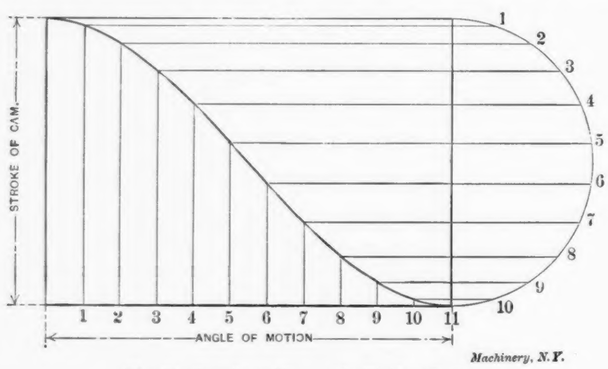


Fig. 2. Crank or Harmonic Motion Curve.

part of the angle of motion would be one unit; in the second part, three units; in the third part, five units, and so on until the maximum velocity has been reached, which would

Number of Period.	Distance Traversed by Follower during one Period.	Total Distance Traversed since beginning of Motion.
1	1	1
2	3	4
3	5	9
4	7	16
5	9	25
6	11	36
7	9	45
8	7	52
9	5	57
10	3	60
11	1	61

be during the sixth part of the angle of motion when the follower would travel through eleven units of motion. At this point the motion would begin to be retarded by a constant deduction which would cause the follower to move through nine units during the seventh interval of time, seven units

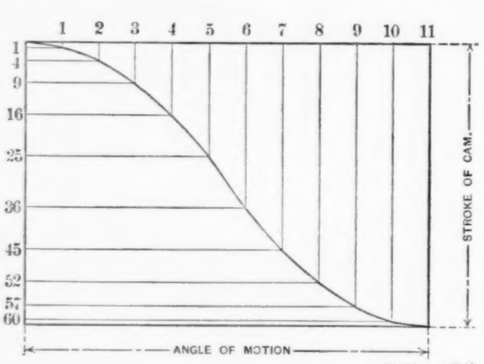


Fig. 3. Gravity Motion Curve.

during the eighth, five units during the ninth, three units during the tenth, and one unit during the eleventh and last interval. The sum of these units is sixty-one, which will necessitate dividing the line representing the stroke of the cam into sixty-one equal parts of which the first, fourth, ninth, sixteenth, twenty-fifth, thirty-sixth, forty-fifth, fifty-second, fifty-seventh, sixtieth and sixty-first will be used for determining points on the curve. The combination of the table given and the diagram shown in Fig. 3 will show how the gravity curve may be drawn.

A very close and satisfactory approximation for the gravity curve, and one that entails less work than the theoretical, is shown in Fig. 4. The method of drawing is similar to the one used for the harmonic motion, excepting that an ellipse takes the place of the semi-circle. It can be seen very readily that the ratio of the major and minor axes will determine the

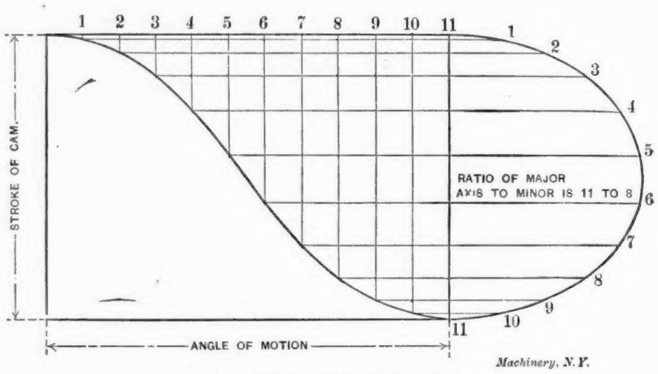


Fig. 4. Approximate Gravity Curve.

character of the cam curve. To obtain a curve that will approximate the gravity curve, the line representing the stroke of the cam should be used as the minor axis and the ratio of major axis to minor axis should be 1⅜ to 1 or 11 to 8. Dividing the semi-ellipse and line of angle of motion into the same number of equal parts, and projecting, we obtain points

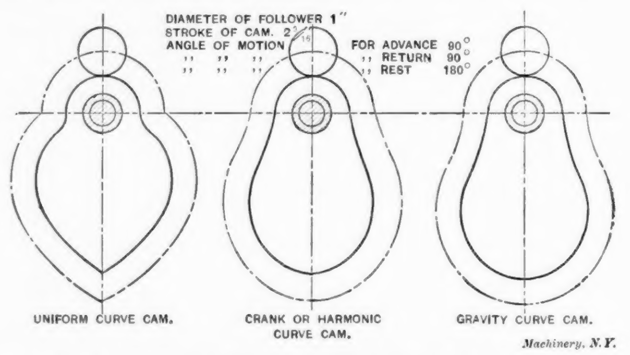


Fig. 5. Comparison between the Different Cam Constructions.

on the curve. Fig. 5 is given so that a comparison may be made of the three motions given above when applied to the same cam.

* * *

The daily newspapers have had a glorious time telling about the wonderful scheme of the Bethlehem Steel Co. offering to teach 3,000 apprentices the secrets of steel making. It is said that Mr. Schwab has evolved a scheme whereby opportunity would be given to 3,000 boys to enter the Bethlehem mills where they would be trained to become not only mechanics, "but experts with a full knowledge of the highest development of the iron and steel business." While we gladly recognize the enormous increase in this line of activity, we still fail to comprehend what the country would do with 3,000 experts with a "full knowledge of the highest developments, etc.," nor can we see that there would be any inducement for Mr. Schwab to undertake to train 3,000 boys with this object in view. It is pertinent to assume, however, that it is workmen and not experts Mr. Schwab is looking for, particularly when we find that there will be no formality in entering the service. Those who wish to start work are simply asked to present themselves at the gates of the mills. Even the machine tool builder, who does not claim that he intends to make an expert of every apprentice, is, we are glad to say, a little more discriminating in regard to the boys started on the road of mechanical success.

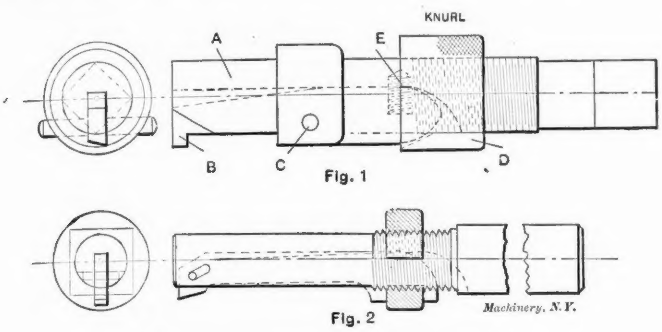
* * *

Judging the size of a port from the tonnage entering it, London is at the present time the greatest port in the world, the tonnage for 1905 being more than 17,000,000 tons. The second place is occupied by New York, and the third by Liverpool.

LETTERS UPON PRACTICAL SUBJECTS.

EXPANDING TOOLS.

Numerous adjustable and expanding tools of different kinds and designs, that are made by manufacturing concerns, supply the general need for such shop accessories. While plenty of shops keep a good stock of almost every such tool on the market, special tools are always more or less necessary. The accompanying sketches show a few such tools that have given excellent service and proven generally satisfactory.



Figs. 1 and 2. Recessing and Slotting Tools.

Fig. 1 shows a tool which is intended for recessing, grooving and chambering; *A* is a bar which may have a taper shank or a straight shank squared for a wrench. The lever or tilting cutter *B* is fitted into a slot in the bar and hinges on pin *C*. The cutter *B* is moved or fed at the cutting point (which may be of the size or shape required) by feed nut *D*, which should have a left-hand thread. This allows the tool to be fed while running right hand by slightly gripping the

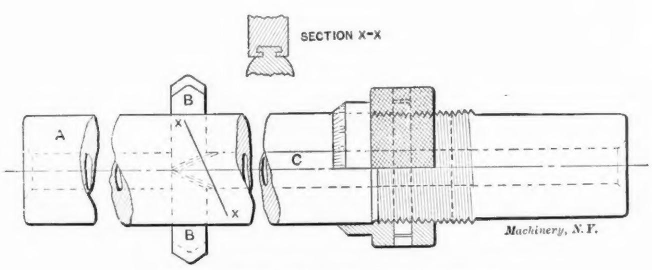


Fig. 3. Boring Bar with Double Cutters.

nut occasionally. This tool is especially useful in recessing and underscoring and preparing holes that are to be tapped a certain depth, or to the bottom. It is well adapted to drill-press work. The cutter is pressed back by spring *E* when the feed nut is run back. This tool works well on any diameter, 5/16 inch and larger.

Fig. 2 shows a slotting tool for cutting keyways in small work, the long, slender ones in long holes that are generally

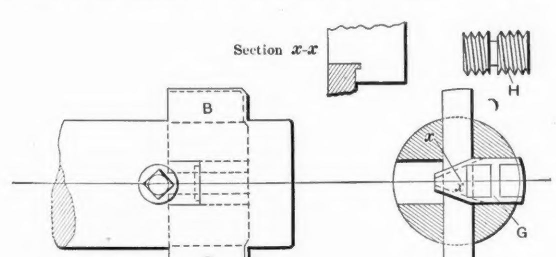


Fig. 4. Expanding Tool for Counterboring and Reaming.

so disagreeable. This tool gives splendid service in holes ¼ inch diameter and larger and may be conveniently used in the shaper by having the shank bent at a right angle. Fig. 3 shows a boring bar with double cutters, although single may be used if desired. Cutters *B* are fitted into a square hole in bar *A* and are fed out by rod *C*, which is provided with a micrometer adjustment, the latter graduated to read to 0.001 inch. This bar is well adapted to vertical or horizontal boring machines or lathe work for boring, chambering, recessing and general work of such character that the cutter is not accessible, but must be fed out or adjusted by some means extending beyond the portion of the bar covered by the work being bored. The cutters are easily removed by running the feed rod back until the dove-tails are disengaged. Fig. 4 shows an adjustable cutter which can be used for general purposes and is well adapted to work where the cutter is to be used near the end of the bar, such as vertical boring and chucking machines, car-wheel boring, etc. Cutters *B* are moved by the dove-tail wedge *G*, which is moved by screw *H*. These designs are varied somewhat at times to suit the work. The tools shown have been in practical use several years and are doing good service to-day, as nothing has been found to satisfactorily take their place. W. S. Marquis.

Washington, D. C.

DIMENSIONING WORM AND WORM-WHEEL DRAWINGS.

Recently, while assisting in building a machine that had a worm drive I noticed that the center distance of worm and worm-wheel was given in decimals carried to three places. Now, why cannot the center distance be given in figures that agree with the graduations on a scale the machinist generally uses, namely, 16ths and 32ds, and the necessary decimal dimension which almost always enters into a worm and worm-wheel design be applied to the diameter of the worm where it can easily be measured by micrometers? For an example let us assume that we have a worm that is 2 inches outside diameter, driving a worm-wheel of 40 teeth, ¼ inch pitch, the pitch diameters being 1.8408 inch and 3.183 inches respectively. Now one-half the sum of the pitch diameters will be the center distance.

$$\frac{1.8408 + 3.183}{2} = 2.5119 = \text{center distance.}$$

Suppose we call the center distance 2.5. The difference will be 0.0119. Multiplying this difference by two and subtracting from the original pitch diameter of worm we have 1.817 for the new pitch diameter. This gives us a worm that is 1.9762 outside diameter, and we can easily caliper to these figures with the micrometer. Of course the angle of thread is slightly changed but so little that it can do no harm. If it would be impracticable to decrease the diameter of the worm owing to it having a large hole, then the diameter can be increased so that the center distance will be in 32ds. Alpha.

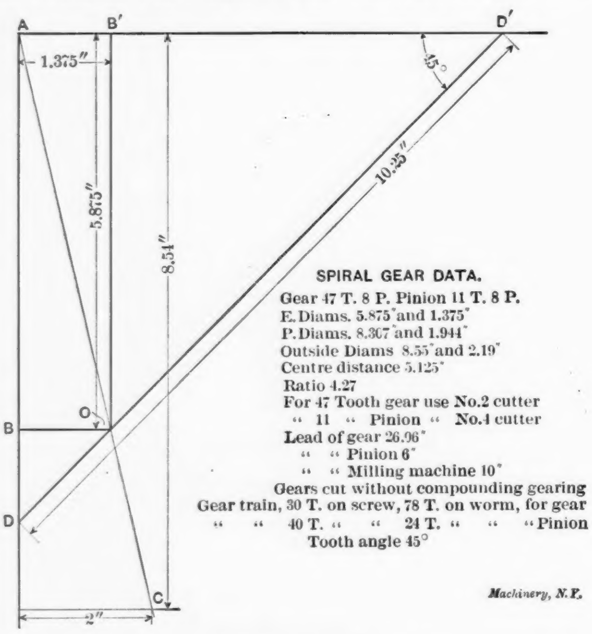
[One objection to the system of dimensioning proposed, and the one which has, perhaps, in many cases prevented the adoption of this way of dimensioning is that the hobs used for cutting the worm-wheels would all be of special diameters, and for each new design of worm and worm-wheel drive, not fully identical with one already made, there would have to be a new hob made. When the worm is made of a standard diameter, any firm having a large number of hobs on hand can often make the worm of such a size as to save the making of a new hob for every new design.—Editor.]

DESIGNING A PAIR OF SPIRAL GEARS.

A few days ago I had the task set me of redesigning a pair of spiral gears with which two previous draftsmen had had trouble. The gears made to the figures they had calculated had to be finished by the cut and try process. It was my first experience with spiral gears, so I approached the matter rather cautiously. I had kept in my file a copy of the May, 1906, issue of Machinery with the article on spiral gearing, and I used this for a start. When I finished the calculations the results were so far away from those obtained by the men who tried it before that I was almost afraid to use them, but I said nothing and sent them out into the shop. The foreman and milling machine man were a little bit skeptical, but everything worked all right, and the only change that was made in anything was the use of a No. 3 cutter where the

figures called for a No. 4. The following diagram and figures show how I obtained the results:

According to the directions given in the article referred to, I first drew lines *A D* and *A D′* at right angles to each other, and then drew the ratio line *A C*. Since I wanted 11 teeth in the pinion and 47 in the gear, my ratio was 47 divided by 11 equals 4.27. On my diagram I located *C* 2 inches from line *A D* and 8.54 inches from line *A D′*, this being in the ratio of 1 to 4.27. I decided to have the gears with a tooth angle of 45 degrees. The center distance between the axis of the gear and pinion was supposed to be about 5 inches, and the diametral pitch of the tooth somewhere near 8. Holding my scale, then, at an angle of 45 degrees with lines *A D* and *A D′*, I moved it vertically upward with the zero graduation on line *A D*, until I found such a position for it as that shown in the sketch, where point *O*, which marks the intersection of the rule with the ratio line, is 11/8 inch from line *A D* and 47/8 inches from line *A D′*. 11/8 inch or 1.375 inch would be the pitch diameter of an 8-pitch spur gear of 11 teeth, and similarly 47/8 or 5.875 inches would be the pitch diameter of a 47-tooth gear, 8 pitch. The distance *D D′* measured on my rule about 10¼ inches; the diagram makes this twice the center distance, so the center distance would be 5⅛ inches—which was near enough to suit



The Solution of a Spiral Gear Problem.

me. *D O* is the pitch diameter of the small gear, 1.944 inch, while *D′ O* is the pitch diameter of the large gear, 8.307 inches. The outside diameter of the two gears was found by adding $2/8 = 1/4$ inch to the pitch diameters of each gear, the same as in 8-pitch spur gears. Next I divided the number of teeth in the pinion by the cube of the cosine of the tooth angle, 45 degrees. This quantity was found in a table in the back of the Brown & Sharpe catalogue, but it may be found in almost any mechanical reference book in tables that are as easily read as a time table is. This division gave me 31 and a fraction. The table in the Brown & Sharpe catalogue stated that a No. 4 cutter should be used for cutting 31 teeth, so this was what the milling machine man was told should be used. Dividing the number of teeth in the gear by the same quantity gave me 123 teeth for this. The catalogue calls for a No. 2 cutter in this case. Following the instructions in the article referred to, the pitch diameter was multiplied by 3.14 and cot. 45 degrees. This gave me a lead of about 6 inches, to which to set the milling machine in cutting the pinion. Multiplying the pitch diameter of the gear by the same quantities gave me a length of about 26 inches to set the machine to in cutting the gear.

The only change that was made from these figures was, as stated before, the substitution of a No. 3 cutter for a No. 4 in cutting the pinion; otherwise the calculation worked out very nicely. CHARLES A. HEALD.

Nashua, N. H

WHERE QUICK JUDGMENT SAVED DOLLARS.

An instance recently occurred which showed how a foreman having that quality which enables him to quickly decide and act to the best advantage in cases of emergency is far more valuable to a firm than one who can only do things in the orthodox way. In a large machine shop, containing large boring mills up to 140 inches, lathes up to 120 inches, large planers, slotters, etc., there were two forty-ton electric cranes on the lower, and an eighty-ton electric crane with two travelers on the upper runway. Once the latter crane was near the end of the shop lifting a heavy job out of a lathe. Suddenly the controller to the hoist motor burned out, leaving the job just off the lathe and tieing up both of the smaller cranes which were in the short end of the shop. The only thing to do, in the opinion of the foreman, was to repair the controller, which was done in the course of three hours, and in the meantime many machines were waiting for crane service which they could not get on account of the two small cranes being held prisoners. The large crane could not bridge away, and the job hanging on the dead trolley was too high to unhook and too low to carry over the machines. The machines thus made idle were all highly rated, and with the machine hands they totaled up to a nice sum before they could resume operations.

A few weeks later a similar accident occurred to the same crane while the hook was too low to pass over the machines. The forty-ton cranes were one on each side of it. This time another foreman was in charge and instead of ordering it to be repaired in the usual way, he disconnected the four motor wires from the burned out controller and attached them to the hoist controller of the second trolley, thus allowing the crane to go about its business while the bad controller was being repaired. The delay was not more than ten minutes. Another similar accident occurred on a single trolley crane some time later when an important shipment was being made and time meant money; the controller of the hoist motor burned out with the job hanging on. In this case the bridge controller was substituted to make the lift, changed back to bridge over the car, then changed again to lower the job off, the total delay not being over fifteen minutes. The money saved in these two cases, by getting the cranes quickly in running order while the controller was being repaired, must have amounted to quite a considerable sum, yet these valuable qualities in a foreman seldom receive consideration.

Philadelphia. MASTER MECHANIC.

[The cases referred to above, in our opinion, are not so much examples of lack or possession of judgment, as of, on the one hand, ignorance and, on the other hand, knowledge of the principles of electrical apparatus. The occurrences, however, strongly accentuate the necessity of the men in charge of machine shop departments being to some extent familiar with the principles of action of all the machinery in their charge.—EDITOR.]

GRADUATING IN THE MILLING MACHINE AND THE SHAPER.

The average shop rarely boasts of a dividing machine or of any means of graduating other than that afforded by tools regularly engaged on general work. When such jobs have to be done they seldom admit of a special expenditure; this, coupled with the fact that clean-cut, evenly-spaced graduations have a "setting-off" effect analogous to that of neat lettering on a drawing, has caused the following suggestions to be proffered.

Much of the work ordinarily encountered is the making of scales. A good miller having feed screws supplied with dials reading to 0.001 inch is well adapted for such work. The divisions are cut with a perfectly sharp 60-degree double-angle cutter set to a depth usually not over 1-64th of an inch; for coarse graduation use a 90-degree cutter. The piece to be graduated is held in the machine just as for any other operation and must be brought in correct relation with the cutter for the first division line. When, by feeding with the table screw, the proper length of line is cut, set the stop, and run up to this each time. If the lines are not to be of a uniform length it is usual to mill the longer one first, going over the

scale again for the others; or if this is inconvenient, a spacing piece may be inserted in front of the stop each time a short line is cut. It is, of course, understood that, after the first line has been made, the dial on the cross feed is used for indexing.

Should the proper cutters not be at hand, the rolling or "squeezing" tool, Fig. 1, is easily made and is capable of long and excellent service. The body, made of steel, is bored to slip on the arbor and the sides of the hub faced true with the hole. The slot at the outer end is a snug working fit for a hardened and ground carbon steel roller. When using this tool the arbor must be secured from turning—otherwise, proceed as with the cutting method. Rolling produces finer finished work than milling, but, as shown exaggerated in Fig. 2,

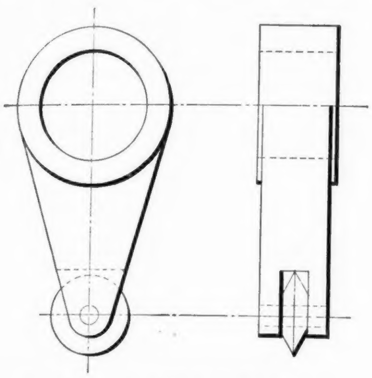


Fig. 1. "Squeezing" Tool for Graduating in the Milling Machine.

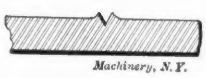


Fig. 2. Exaggerated Appearance of Impression Made by the Squeezing Tool.

always throws up a burr that has to be removed. This tool cannot be used to advantage on cast iron or for light accurate work. Another class of work frequently met with and best done on a milling machine calls for graduations on the outside surface of a cylindrical piece. Such pieces are put on centers and the dividing head used for indexing. A milling cutter or squeezing tool is used for obtaining the graduations the same as before.

For shaper work use a 60 to 90-degree V-point tool. To make smooth lines it is absolutely necessary to have a sharp tool; hence (if the graduations are not to extend clear across the work), to prevent constant dulling of the point, provide a slight groove at the end of the lines into which the tool may run. Rolling can be done in the shaper with a tool similar to the one described for the miller, except that the shank is made to fit the tool-post and the machine is run with the clapper blocked. Here, again, this method leaves the smoother finish and does away with the drag of the clapper and consequent grinding of the V tool necessary. The shaper not being

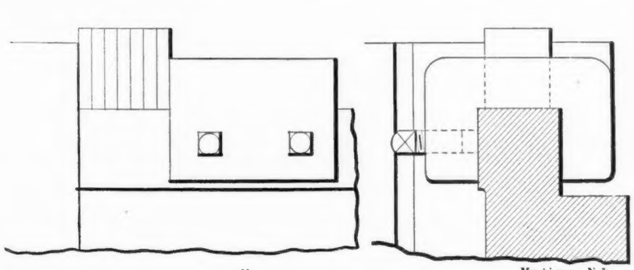


Fig. 3. Graduating in the Shaper.

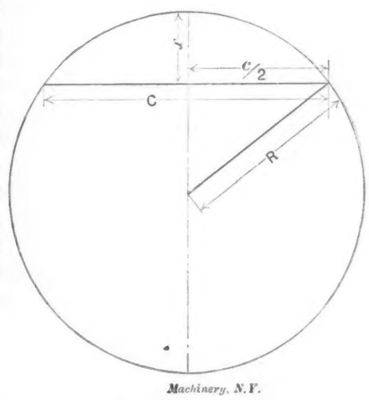
supplied with a dial on the feed screw, some other way of indexing must be resorted to. One method is to make a clamp, Fig. 3, of cast iron or steel to slide on the top rib of the cross rail and secured by setscrews having brass plugs in front of their points. A number of spacing pieces, of a thickness equal to the "lead" of the scale to be cut, are provided. These are placed between the clamp and the saddle, as shown at a, Fig. 3. One spacing piece is removed for each line cut, and the saddle moved up against the remaining pieces. When all have been removed, the clamp is shifted and the operation repeated.

Less accurate graduations may sometimes be laid out with dividers or marked from existing surfaces. For such cases, the scale surface is coated with copper solution and the lines scratched on it, the work being then put in the shaper or miller and the divisions cut as nearly as possible to the scratched lines. DONALD A. HAMPSON.

Middletown, N. Y.

R. S. SOLVES A PROBLEM.

The editor of MACHINERY has sent me a letter which he has received from one of his more or less valued correspondents. It is a pleasure to me to say that the correspondent in question is very anxious about my health and general welfare, all of which, of course, is very agreeable to me, and makes me realize that others have recognized what I have long known myself, namely, that I am a person of importance and of interest to the public at large. The correspondent in question, however, in all his kindness still seems to doubt my extraordinary mathematical ability, and after having said some things he ought not to have told about his former teachers and instructors, he submits to me the problem of finding the radius of a circle when the length of an arc and the corresponding chord are known. It almost hurts my feelings that he should even suspect my incapability of attacking so simple a thing as this. Now suppose that C is the length of the chord and l the length of the arc. Let R be the radius to be found. The height of the arc we will call x. We have now two unknown quantities, R and x. If we can get two equations containing these quantities we can eliminate the one in one equation, and thus solve our problem. It is easily seen that



R. S. Solves a Problem.

$$R^2 = \left(\frac{C}{2}\right)^2 + (R - x)^2 \qquad (1)$$

According to a geometrical proposition (Euclid, III., 35) the rectangle contained by the parts of each of two chords intersecting in a circle are equal. Thus,

$$(2\,R - x)\,x = \left(\frac{C}{2}\right)^2 \qquad (2)$$

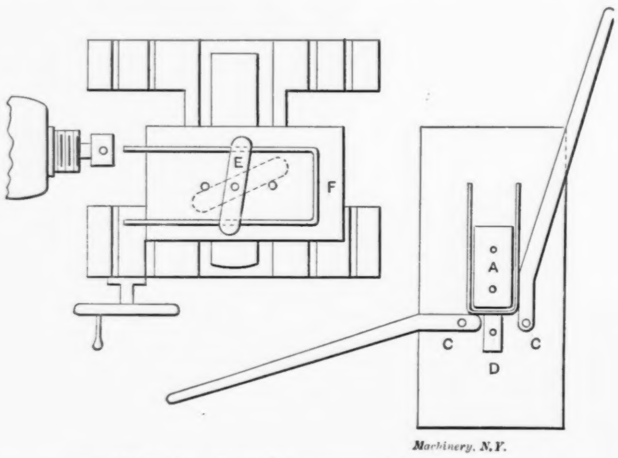
If x is solved in equation (1) and its value inserted into equation (2), this latter reduces itself to an equation with one unknown R, which can then easily be determined. I am, however, too busy at the present time promoting a company to launch my perpetual motion scheme to be able to demonstrate in full how simple the problem is. Let me say in conclusion that it is gratifying to know that the world is growing wiser every day. This is conclusively proven by the fact that only a very few people have reflected upon spending their hard-earned cash in buying the sole right to my perpetual motion. Those who have done so, I thank for their kindness, and assure them of my profound sympathy. R. S.

TOOLS FOR BENDING AND THREADING IN A SMALL SHOP.

An order for five thousand 5/16-inch round pieces of wrought iron, bent to a "U" shape and threaded for standard nuts at the ends was received at a small shop, so small indeed that a working force of two men and three boys was considered ample for rush seasons. However, it was the only machine shop within twenty miles, and many and queer were the jobs which fell to its lot. A slab of cast iron 36 x 18 inches (the shops laying out plate) was set up in the middle of the floor, its upper surface being about the same height as a low table, a piece of boiler plate A was chopped out and ground to the inner shape of the sample piece. This was bolted to the center of the cast iron plate, and two levers were made and fulcrumed at pins C so that when a piece was placed in position and the levers forced around (boy power, the smaller the boy the longer the handle) the required shape was the result. D is a strap bolted behind A, which keeps the work up to its place. A stop was provided at one

side, so the boys would get the pieces central without loss of time.

Threading the ends was the next operation. The compound rest of *the* lathe was removed and in its place a large block of wood was bolted down, on the upper side of which a groove was hollowed out to the U-shape of the wire, and so that when a piece was laid in, it came flush with the surface and the two ends protruded over the forward end about 1½ inch and were level with the lathe center line. A swiveling

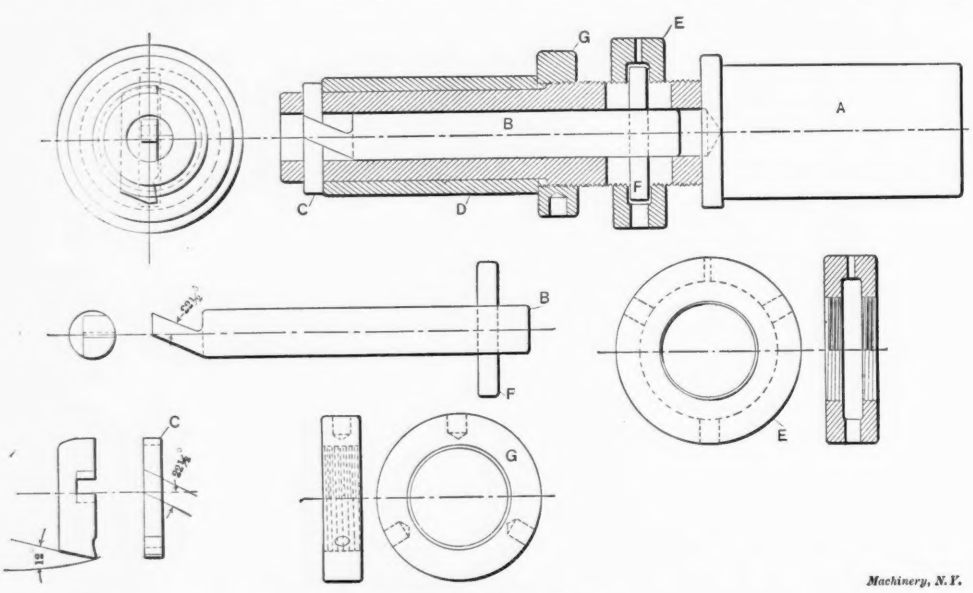


Simple Bending Rig and Arrangement for Threading.

iron clamp *E* served to hold the piece in place, and the thrust of starting the thread was borne by the wood at the end at *F*. The cross-feed screw was removed and the operator after threading one end pushed the whole thing over until the other end was in a position to enter the die and then gave it a start with the hand-wheel on the carriage. The lathe was never stopped except at the moment of reversal, and I dare say, as these moments were short enough to be unobserved by the average eye, many would-be philosophers argued that the lathe never stopped at all. W. L. McL.

SCREW MACHINE RECESSING TOOL.

The accompanying cut shows a screw machine tool for recessing castings which, beside being simple to operate, is an important factor in turning out work accurately and rapidly. In the cut, *A* represents the holder, one end of which fits the turret of the screw machine, while the other end is



Screw Machine Recessing Tool.

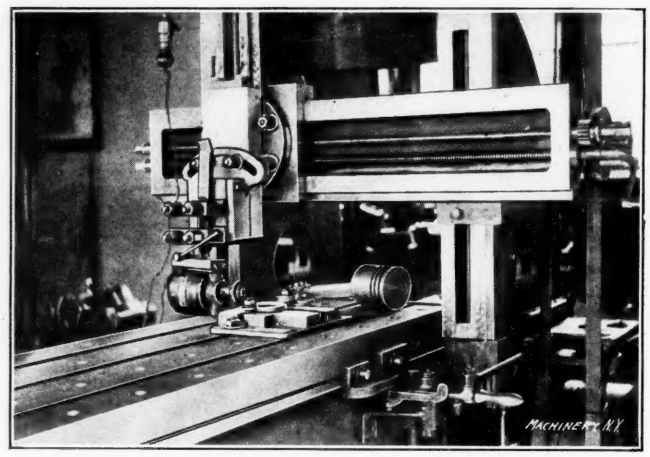
bored to receive rod *B*. One end of this rod is milled to allow adjustment in both directions for the tool steel cutter *C*, which in turn is slotted to suit the angle on the end of the adjusting rod. Bushing *D* acts as a pilot, being turned to the bored diameter of the work. Adjusting nut *E* is screwed on the threaded portion of holder *A* and moves the pin *F* which is driven in the end of rod *B*, the travel being guided by the slot in *A*. Check nut *G* is used to regulate the depth of the cut and is operated on the same thread with *E*. Both nuts are of machinery steel, casehardened, knurled and provided with three holes permitting the use of a spanner wrench.

The operation of the tool is as follows: Adjusting nut *E* is screwed forward until the cutter is set to the depth of the cut desired. Check nut *G* is then set against adjusting nut *E*, which is screwed back until the cutting point is below pilot bushing *D*. The turret is then fed forward, bringing the tool into the work. Adjusting nut *E* is gradually brought up against check nut *G*, bringing the cutting point to its full depth. When this is done the automatic feed of the machine is thrown in and the tool performs its work. The only qualification necessary to make a tool of this kind universal for various sizes of work is to provide pilot bushings and tools to suit the required diameters. W. T. M.

GRINDING PISTON RINGS ON THE PLANER.

The use of a 24-inch x 6-foot planer for grinding 4-inch gas engine piston rings is, to say the least, hardly good practice, but in our case it seemed to be the most feasible way of accomplishing our purpose, since there was no surface grinder available. The device was arranged as shown in the cut. A small electric grinder with ¼ x 3 inch emery wheel was fastened to the tool box of the planer, and a raising table, taken from the milling machine, was bolted to the platen. The rings were turned on one side in the lathe before being cut off. They were then fastened to the table by two bolts with washers. The ring was allowed to project slightly over the edge of the table so that it might be measured with micrometers. Having measured the tool used to groove the pistons, any desired fit could be obtained. Only one-third of the circumference could be ground at one time, necessitating three changes. The time consumed was seven minutes, but this could have been reduced by using a wider-faced wheel. The fit of the rings in the piston groove when thus ground was all that could be desired. C. F. Moore.

Rochester, N. Y.

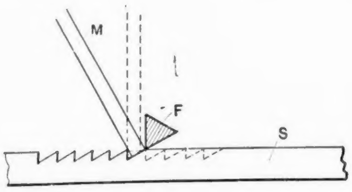


Grinding Piston Rings on the Planer.

HOW TO MAKE A SAW.

The following is not intended to give you an idea of how to start in the saw-manufacturing business, nor does it mean that this is the only way of making saws. But it is intended to show that for some emergency purposes, ever occurring, you can without great efforts and skill make a good saw in a short time. In Fig. 1 are shown the triangular file *F*, the

"saw to be," *S*, of some spring tempered steel blade, and a piece of metal (or end of a file) *M*, this latter varying in thickness according to the size of tooth wanted. Now all you have to observe is to file the first tooth with a few strokes of the triangular file to the proper depth, to insert piece *M*, which serves as stop, and file the second tooth, and so on, always trying to get the teeth as uniform as possible. By changing the angle of *M*, the size of the teeth may be increased or decreased without going into trouble of searching for an exact piece to fit. Remember as well, that a saw with undercut teeth will saw iron and steel, while teeth cut down straight as shown in the illustration will be suitable to cut brass, bronze, etc. To avoid the cumbersome job of staggering the saw-teeth sideways, you may as well raise a burr at the point of same by a light hammering of the points with a small hammer and afterwards refinish them with the file, giving



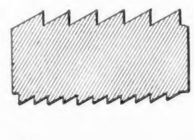


Fig. 1. Making a Saw with a three-cornered File.

Fig. 2. Section of Special "Saw-file."

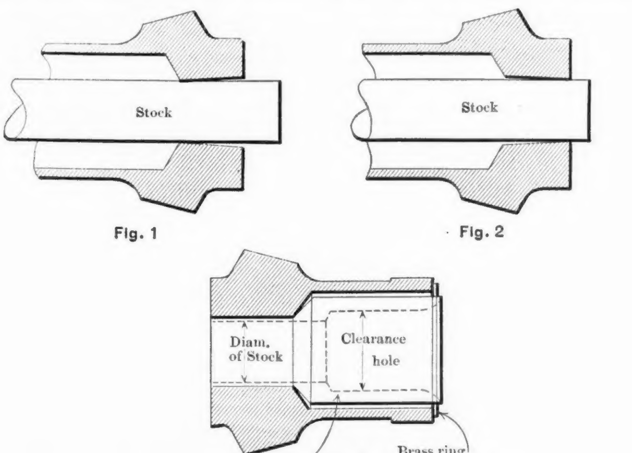
a sharp cutting edge. The burr being left on will prevent wedging of the saw in cutting metals. This method of making a saw is rapid and saves you, in time, lots of annoyance, especially when cutting narrow slots, for which purpose generally no files can be had the moment they are wanted.

Fig. 2 shows a section of a "saw-file" which the author has seen used in a shop down south, turning out surgical instruments, and is a more fitting means of doing aforesaid trick with much greater accuracy and in still shorter time; it will prove indispensable to those who find it of value to make their own saws as it will cut from 5 to 20 teeth at a time—depending upon number of teeth to the inch and width of file. The use of this tool is self explanatory, the cost of manufacture is little, and if put into proper use will be a jewel in the tool box. MAX J. OCHES.

Cleveland, Ohio.

BUSHING FOR TURNING ODD DIAMETERS IN THE SCREW MACHINE.

Most screw machines are equipped with a series of spring collets or chucks for holding stock of different diameters. The sizes of these collets or chucks on the larger sizes of machines usually vary a sixteenth of an inch. It is frequently the case that stock of an odd diameter has to be turned up. Of course, for very small variations from standard sizes it is quite practicable to adjust the tightening clutch at the other end of the spindle. Let it be required, however, to hold stock that varies one thirty-second of an inch from the nearest size chuck, say for instance 19/32-inch stock; now, a 9/16 chuck



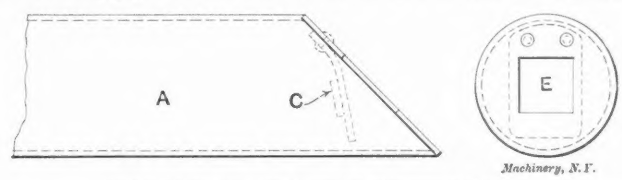
Action of Screw Machine Chucks not Fitting the Stock, and Bushing for Odd Diameters of Rod.

is too small, and a 5/8 chuck too large for this diameter. To attempt to adjust either of these chucks to hold the stock, puts an undue strain upon them, and, in the writer's experience, has broken a number of chucks. Moreover, the stock rarely runs true, and is not held firmly as only the front or rear end of the chuck grasps the stock (Figs. 1 and 2). To overcome this, the writer has tried the following device which consists of a brass bushing as shown in Fig. 3. It is made about 1/16 inch longer than the chuck to which it is soldered by means of the brass ring shown in the figure. It has, of course, slots corresponding to the slots in the chuck to allow opening and closing of the chuck and bushing. These slots, however, do not extend the full length of the bushing, but just far enough to give a suitable amount of spring to it. This device has been found entirely satisfactory and is very inexpensive, and moreover, saves the risk of breaking the chuck. FREDERICK WALSLEBEN.

Brooklyn, N. Y.

SAFETY VALVE FOR BLAST PIPES IN BLACKSMITH SHOPS.

Reading in the February issue of MACHINERY an article by Albert P. Sharp on safety valves for blast pipes brings to my mind a case that occurred to me several years ago. Due to the accumulation of gas in a large blast pipe, an explosion resulted, wrecking the whole shop. Knowing that the same thing would occur again unless something was done to prevent it, the device shown in the accompanying cut was devised. This device answers, I think, fully as well as the method proposed by Mr. Sharp and will cost only a quarter or less of what his device would cost. Referring to the cut, *A* is the end of the blast pipe, which in most cases is 6 inches in diameter



Safety Valve for Blast Pipes in Blacksmith Shops.

or more. This end should be cut off at a slant of 45, 50, or 55 degrees. A piece of galvanized iron should be fitted to the end as a cover and then a square hole *E* cut in the cover. A piece of leather, for instance, the thickness of belting, cut large enough to cover the hole *E*, and long enough to allow for rivets at the top, and with a piece of lead *C* to act as a weight, is fastened to the galvanized iron cover, as shown, to complete the valve. When the pressure is on, the leather cover is forced over the opening *E* and closes it, but when the pressure is off the leather drops down by the action of the leaden weight and allows the passage of air and gases through the pipe. This idea, I think, is original, simple, cheap and absolutely safe. I have introduced it in several shops which I have equipped. GEORGE T. COLES.

Chicago, Ill.

I CAN'T DRAW, BUT I KIN WHITTLE.

Some years ago I was running a machine shop with foundry and pattern shop connected, manufacturing one or two specialties, which was hardly enough to keep the shop running to its fullest capacity. I did not like the idea of taking in hurry jobbing work, as that would interfere with our system of manufacturing, so I decided to advertise that we were prepared to build special or experimental machinery, and issued the following bulletin:

ATTENTION INVENTORS—A LONG-FELT WANT FILLED.
The undersigned now offers you the services of from ten to fifteen first-class mechanics, equipped with the latest improved machine tools suitable for building large or small machinery. All inventions kept strictly on the quiet, and warranted *not to leak*.

In less than one week I had to hire an additional typewriter, and it took all my time dictating answers to fellows who had an "idea" and wanted me to design the machine, all the way from a hog ringer to a valveless steam engine.

I had adopted Professor Sweet's idea of throwing the shop wide open to visitors, as a kind of advertising exhibition. These inventors swarmed into the shop, stood over the workmen, and asked them why they did the work in that way, or

why they did not do it in some other way, until my patience was exhausted. One morning I went into the pattern shop, and there was a tall, raw-boned Hoosier. He had on a big, rough straw hat, such as farmers use when plowing, and a long linen duster that reached down to his heels. He was standing at the back of the leading pattern-maker's bench, leaning half way over, and almost under the pattern-maker's nose held the index finger of his left hand in a horizontal position, using the finger and thumb of his right hand as a pair of calipers, and was calipering his index finger first at one end and then the other.

As I came up, the pattern-maker said to the stranger, "This is our superintendent, I did not get your name." The stranger turned to me and said, "My name is Wellwater, from Pike County, Missouri." Continuing, he said, "I was trying to explain to your man here what I wanted, but he don't seem to catch on."

"Have you a drawing of what you want made?" I asked.

"Drawing," said he, "I ain't got no drawing. I guess I can tell you better than with a drawing what I want. You see, I am getting up a corn-planter, I mean a corn-dropper, or that is, I want a valve made for a corn-dropper, one as will drop four grains in a hill, no more, no less, and not chop the corn into hominy, either."

"That is an excellent idea," I said, "but, as you cannot furnish a drawing we will have to charge you fifty cents an hour for talking."

His hands shot into his duster pockets, he leaned forward, stuck out his chin and looked me straight in the eye, and said, "Is that so?" Then he turned on his heel and left the shop. In half an hour or so he returned, tapped me on the shoulder, and said, "Say, can you make me a couple of pieces like that?" at the same time taking from his pocket a model of the valve which he had cut from a potato. When he previously left me he went up to the corner grocery and got a potato, sat down on the curb stone and whittled out a model, the exact size and form of the valve he wanted made. It was really an artistic piece of carving, the curves were smooth and graceful. It was hollowed out, leaving the walls and bottom about one-eighth of an inch thick, and the two side lugs, intended to receive the connecting pin, were reinforced with proportional bosses. I could not help admiring the rounded corners and graceful curves.

Holding up the potato model between his big, rough fingers, he said: "I can't draw, but I *kin* whittle." THOMAS HILL.

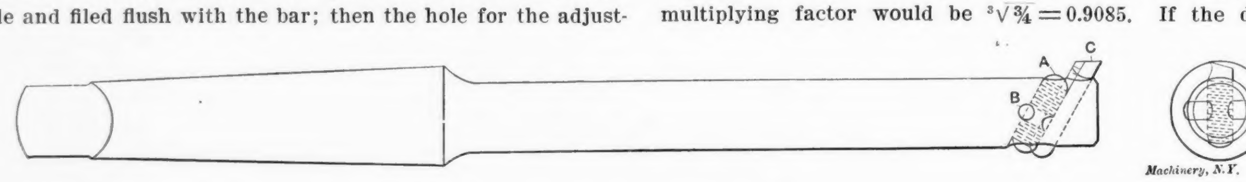
Quincy, Ill.

BORING TOOL FOR MILLING MACHINE.

The accompanying cut shows a boring tool which is very useful for boring holes in the milling machine. The object is to get a very fine adjustment, which is usually difficult on common boring tools. The adjustment is secured by turning the adjusting screw *A* which is prevented from longitudinal motion by a small pin *B*, engaging into a groove in the screw *A*. The cutter, of course, must be threaded on one side to engage with the screw. In making this tool I first drilled the hole for the cutter. After this, a pin was driven in the cutter hole and filed flush with the bar; then the hole for the adjusting screw was laid out and drilled. This hole is a plain hole, not tapped. Last of all, the pin hole *B* was drilled and the pin put in place after the adjusting screw had been inserted.

Hartford, Conn. R. P. JORGENSEN.

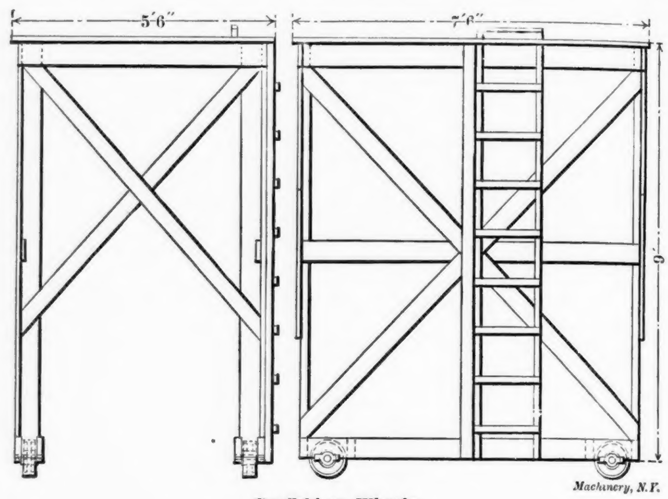
[Many of the readers of MACHINERY will probably recognize the construction of this boring tool as being the same as that of the Pratt & Whitney thread tool-holder, where use is made of an adjusting screw inserted in a similar way and engaging with a thread on the back of the single point cutter or chaser. However, the use of this construction in the present tool is novel and may prove advantageous in many cases.—EDITOR.]



Boring Tool for Use in Milling Machine

SCAFFOLD ON WHEELS.

A platform built on the manner shown in the cut is a great help in placing or repairing overhead pulleys and countershafts. For whitewashing and painting ceilings this scaffold is also very useful. The bracing is arranged so as to straddle the ordinary machine tool. A ladder is built on one side as shown. The wheels are of cast iron, 9 inches in diameter, 3 inches face. The axles, which run loose in cast iron boxes, are pressed into the wheels. A hand-hold on top of the platform, about 10 inches from the edge, facilitates in climbing up on the top. The platform is 7 feet 6 inches by 5 feet



Scaffold on Wheels.

6 inches and 9 feet from the floor; the height, of course, should be to conform with the height of the shafting.

To keep the shafting clean of oil and dust a pair of large "shears" of wood are used. A man standing on the floor holding the long ends, and having waste between the short ends, squeezes the shaft between the short ends, thereby polishing or cleaning the shaft. A. D. KNAUEL.

Moline, Ill.

THE FUNDAMENTAL PRINCIPLE OF PROPORTIONING MACHINE PARTS.

It frequently happens that it is desired to make some machine part of the same proportion as one already made, but having its weight, or strength, or some other property, either greater or less than that of the model, in a certain known ratio. A convenient way to obtain the new dimensions is to determine the algebraic power of the desired property, and to find the corresponding root of the known ratio. This may then be used as a factor with which to multiply the dimensions of the model to obtain the desired dimensions. Let it be desired, for instance, to find the dimensions of an anvil which shall have the same proportions but weigh three-fourths as much as one already designed. Since the weight is proportional to the volume, which has three dimensions, the multiplying factor would be $\sqrt[3]{3/4} = 0.9085$. If the desired weight is $1\frac{1}{2}$ that of the first anvil, the factor would be $\sqrt[3]{1.5} = 1.143$. Other instances where this method of multiplying factors would be useful are in determining dimensions of areas, where one, of course, makes use of the square root of the ratio; in determining size of shafting, working from a known condition, and section modulus of a beam, both of which cases require the third root of the known ratio; and the moments of inertia of sections, requiring the fourth root of the ratio. These are but a few of many applications that will readily suggest themselves. G. M. STROMBECK.

Urbana, Ill.

SHOP KINKS.

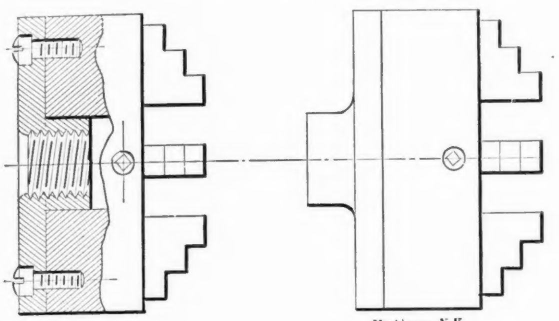
A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

In the description of the emery wheel dresser by Roy B. Demming which appeared in "Shop Kinks" February, 1907, it should have said that thin iron washers are used instead of tool steel, as there stated. These washers are made from sheet iron or Russian iron.

IMPROVED METHOD OF FASTENING THE LATHE CHUCK TO THE FACEPLATE.

To the left of the cut is shown an improved method of fastening a lathe chuck to the faceplate instead of fastening it as shown to the right of the cut, which is the usual way. Two important advantages are obtained by this change of method. The chuck will come nearer the bearing and a much

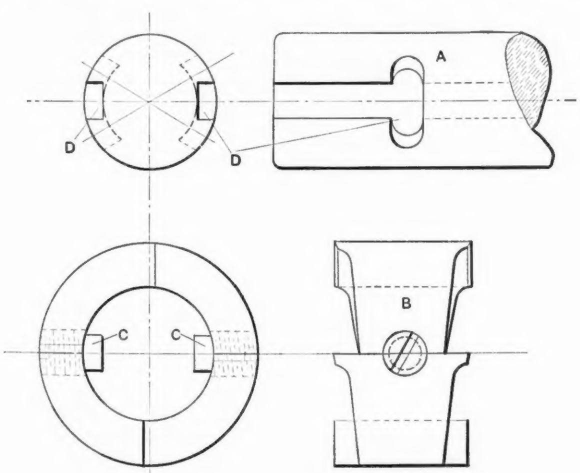


Machinery, N.Y.

stronger construction is possible. The method, as is plainly shown, consists of screwing the inside face of the faceplate to the chuck and allowing the hub to fit the inside of the chuck, the faceplate being finished all over and simply reversed from its usual position, which is to have the hub toward the lathe spindle and the face of the plate toward the chuck. WINAMAC.

FACING CUTTER.

A very useful and convenient form of cutter for facing around holes, either on top or bottom side of the work, is shown in the accompanying cut. *A* is the bar which may have straight or taper shank as required. *B* is the cutter which should be cut right and left hand as shown; it is held on the bar and driven by two screws *C C* which fit into slots *D D* of the bar. For facing around holes on the under side of

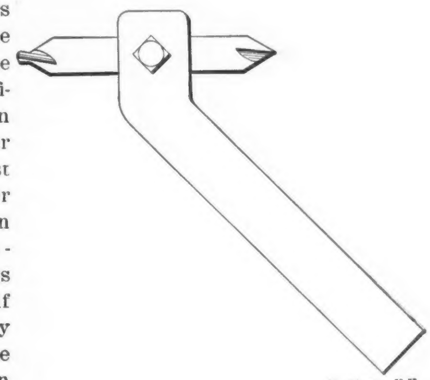


Machinery, N.Y.

flanges of large castings, where the end of the bar is first to be run through the hole and the cutter attached afterward, this cutter is easily put on or removed from the bar while it is running, thus saving much time otherwise lost by stopping. When desired, the keyways on each side of the bar may be cut their full length as indicated by the dotted lines; several sets of notches may then be cut to locate the cutter at different positions. M. S. W.

CENTER DRILL HOLDER.

The tool shown in the accompanying cut has proven itself a time-saver when centering work in the lathe, particularly shafting. The shank of the tool fits the tool-post and holds an ordinary center drill. One of the ends of the latter has the tit ground off and the lips are given sufficient clearance. When reversed in the holder this makes a most substantial tool for taking up centers. An examination of discarded center drills will show that few if any fail except by breaking off at the end where they join into the countersink.



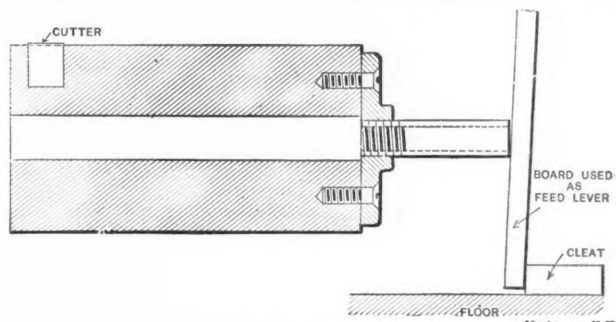
Machinery, N.Y.

To prevent this, grind off the drill part to less than half its original length, even shorter than shown in the cut, and the center drill can be depended upon not to break off, but to actually wear out. DONALD A. HAMPSON.

Middletown, N. Y.

A HOME-MADE BORING BAR.

We had occasion to send the water end of our boiler feed pump to the shop for boring and on getting it connected up ready for work again, we found it did not work as it should. It was packed with a special hydraulic packing, made to fit the cylinder; this would go tight into the outside ends, and after banging awhile, go to the other end with a rush. When



Machinery, N.Y.

calipering the cylinders, they were found to be smaller at the outside end, causing the packing to wedge in hard, while it was loose at the opposite end. Not wanting to again dismantle the pump we decided to rebore the cylinders, which were lined with bronze, in place. An oak block of the diameter of the cylinders was procured, and into one end of this was driven a file end, ground to the proper shape to form a cutter. On account of the location of the pump, the block could not be turned with a crank, so a floor flange was screwed to one end, and a piece of $\frac{3}{4}$-inch pipe of the required length screwed into the flange, the whole then being turned with a Stillson wrench. A hole was bored the full length of the block, so it was not necessary to remove the piston rods, but merely the plungers. A cleat nailed to the floor, with a piece of board for a lever furnished the feeding attachment. The cutter was set to the larger diameter of the cylinders, so nothing was cut out at the inside ends, and one setting answered for both sides. The pump ran as it should after this operation was performed. J. V. N. CHENEY.

South Portland, Me.

TO SHRINK HARD RUBBER.

Some time ago the cap of my fountain pen had worn so loose that it frequently dropped off. I held it a few minutes over a hot stove with the open end of the cap downward, and was pleased to find that the diameter of the opening decreased sufficiently to cause the cap to fit the pen holder just right. I have used the pen several months since the experiment, and the cap is still all right. This idea may be used in other cases in which hard rubber is employed.

Atlanta, Ga. W. S. LEONARD.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it provided it has not already appeared here.

324. SUBSTITUTE FOR RED LEAD APPLIED TO JOINTS.

As a substitute for, or in the absence of, red lead, use varnish on air or steam pipe joints. It will dry very hard and last for a long time. DONALD A. HAMPSON.

Middletown, N. Y.

325. CHEAP FLOWING SOLDER.

A cheap soft solder which is good for purposes where not much pressure is carried, is made by adding to each pound of lead, while melting, one teaspoonful of common salt.

Ashtabula, Ohio. C. L. SCOVILLE.

326. FILLING FOR CAST IRON.

One-quarter tumbler full of Japan dryer, 1½ ounce finely ground dry white lead. Mix and add 1 quart of finishing Japan. Stir in dry rotten stone until mixture is a thick paste. E. H. MCCLINTOCK.

West Somerville, Mass.

327. TO WELD SPRING STEEL.

An experienced blacksmith has used for years the following in welding steel springs. Just before the steel comes to a welding heat he placed a small piece of Russian sheet iron—such as stove bodies are made of—on the joint; this melts and runs into the joint so that the weld is perfect. X. Y. Z.

328. METAL POLISH.

A good metal polish for gold, silver, brass, nickel, etc., can be made by taking powdered crocus and mixing enough kerosene oil with it to make a paste. This paste must be rubbed very thoroughly over the article to be polished. Then take a flannel cloth and rub lightly and rapidly until a brilliant polish is obtained. HERBERT C. SNOW.

Cleveland, O.

329. CEMENT TO RESIST WHITE HEAT.

A cement that will resist white heat may be made of pulverized fire clay 4 parts; plumbago, 1 part; iron filings or borings free from oxide, 2 parts; peroxide of manganese, 1 part; borax, ½ part, and sea salt, ½ part. Mix these to a thick paste and use immediately. Heat up gradually when first using. W. R. BOWERS.

Birmingham, Eng.

330. BLACK OXIDE COAT FOR STEEL.

A fine black coat is produced on steel if treated in the following manner: An oxidized skin is first produced in some suitable manner on the surface of the steel; this is converted into black oxide by means of hot water and continued until the coat of oxide is thick enough. Then the articles are dipped in lukewarm water to remove any acid or salty particles, and then some olive oil is poured over the whole. D.

331. USE OF GLUE.

A mistake not uncommonly made by infrequent users of glue is to break up dry glue in hot water. This is bad practice as the adhesiveness is greatly impaired. Always soak dry glue in cold water and then cook, but do not cook too long as that is injurious also. Glue that has soured should not be used, and every precaution should be taken to keep it sweet if the best results would be obtained. M. E. CANEK.

332. UNCHANGING GLOSS ON CAST IRON.

The articles are well scrubbed with a diluted acid, dried and smoothed with a file, wire brush or the like. Then they are rubbed repeatedly with ordinary crude petroleum and let dry each time; finally they are well rubbed with a hair brush, which gives them a dark glossy appearance which will stand heat and serve as protection against rusting. Articles once treated in this manner need later on be only rubbed with petroleum and brushed up again. D.

333. BELT CEMENT.

Put 15 pounds of best glue in a kettle and pour over it 5 gallons of cold water. Let it stand a few hours or over night in a cold room, after which dissolve by gentle heat. Stir in one pint of Venice turpentine and add one gallon of Martin's belt cement. Cook for four or five hours by gentle heat, being careful not to boil the mixture. A water or steam jacketed kettle should be used to avoid burning. If too thick, mix with water. ALBERT F. BABBITT.

Attleboro, Mass.

334. MAKING WAX IMPRESSIONS.

It often happens that it is required in the manufacture of goods to make a wax impression of a sample or model. To do this successfully proceed as follows: Oil the surface of which the impression is to be made very slightly with a few drops of oil applied to a little waste. Then take common beeswax, melt it slowly, but do not boil it. Mix it with one or two tablespoonfuls of lamp black to half a tumbler of beeswax and stir the mixture. In order to make the wax impression show up clearly, take a fine hair brush and brush a little powdered graphite or rouge over the object on which the impression is to be made. C. W. SHELLY.

Wallingford, Conn.

335. TO FIREPROOF WOOD IN FORGE SHOPS.

To protect the woodwork around or near a forge apply three coats of 3 parts alum and 1 part copperas, dissolved in water. Apply hot, and only allow sufficient time between applications for the preparation to saturate the wood. Follow this with a fourth coat composed of solution of copperas made to the consistency of paint by mixing with fireclay. This treatment will not only render the wood fireproof but will preserve it for many times its ordinary life.

Another fireproofing mixture for the same purpose is composed of 3 parts ground wood ashes and 1 part boiled linseed oil. This is applied with a brush.

Still another fireproofing treatment consists of three applications of a hot solution of phosphate of ammonia. The last two treatments require renewing at least once a year.

E. W. NORTON.

336. DISINFECTANT.

It is frequently necessary to disinfect our offices or shops; a very effective and inexpensive means is as follows: To 6¼ ounces of crystals of potassium permanganate, add one pint of formaldehyde (40 per cent) for every 1,000 cubic feet of room space. The disinfectant should be mixed in a metal receptacle having at least ten times the volume of the ingredients used. This is required to prevent the mixture from boiling over. The receptacle holding the crystals should be placed near the center of the room which is to be disinfected, after ascertaining that all doors, windows, etc., are securely calked to prevent the gas from escaping. The formaldehyde solution should be ready to be poured upon the crystals, which must be done quickly. The room must then be left closed for at least thirty-six hours to obtain the best results.

Denver, Colo. E. W. BOWEN.

337. HARDENING COMPOUND.

In hardening small tools, some of the more delicate and essential parts of the tool to be tempered are very apt to be overheated and burned unless extraordinary care is exercised. The following is descriptive of a compound that can be used to prevent over-heating of such small delicate instruments during the process of tempering. Dissolve 2 ounces of pure Castile soap in enough warm water to make a thin paste, and add to it the contents of a five cent package of lamp black, mixing it well into a stiff paste. This must be kept securely sealed in a can. To use the compound, slightly warm the small tool or object that is to be hardened, and smear the paste all over it. When dry, heat and quench in the usual way. As the paste is removed by the bath, the work will be clean enough to observe the color in tempering. T. E. O'DONNELL.

Urbana, Ill.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

Toolmaker.—Can you give me any information in regard to the Jarno taper? Are there any tables available anywhere for this taper, the same as for the Morse and the Brown & Sharpe standard tapers? What is the Jarno taper used for?

A.—The Jarno taper was proposed several years ago by Mr. Oscar J. Beale of the Brown & Sharpe Co. The taper per foot of all the Jarno taper sizes is 0.600 inch on the diameter. The Jarno taper has the advantage over the other two standard tapers mentioned in the above question in that there is an exact relationship between the diameter of the large end, the diameter of the small end and the length between the places where these diameters are measured, and this relationship can be expressed by simple formulas. The sizes of the Jarno tapers are known by numbers from 2 and upwards, and by simply designating the number of the taper, all other necessary dimensions can be determined by means of the formulas.

Let $N =$ the number of Jarno taper,
$D =$ the diameter of the large end,
$d =$ the diameter of the small end, and
$L =$ the length of the taper.

Then, $D = \frac{N}{8}$, $d = \frac{N}{10}$, $L = \frac{N}{2}$

If, for instance, we want to determine the size of a No. 7 Jarno taper, we find from our formulas that the diameter of the large end is $\frac{7}{8}$, the diameter of the small end 0.700 and the length $3\frac{1}{2}$ inches. If we figure the taper, we will find it to be 0.600 inch per foot, as stated before. As far as we know, there are no tables available outside of the manufacturing establishments where this taper is used, but on account of the simplicity of figuring the dimensions for the taper, no tables are actually required. This taper, although it has some very decided merits on account of being, one might well say, the only system of standard tapers founded on a scientific method, has not been used to any great extent. The Pratt & Whitney Co. has commenced to use it of late for several of their new designs of machines, particularly profiling machines, but it is safe to say that the old standard tapers, the Morse and the Brown & Sharpe do still hold their own in almost all ordinary machine shop practice.

C. K.—Kindly work out the spiral gearing problems indicated in Fig. 1; for each of the two cases the ratio is 1 : 1. The shafts are at right angles and the gears are to run at about 500 revolutions per minute. Also, will you please look over the following dimensions given for a pair of spiral

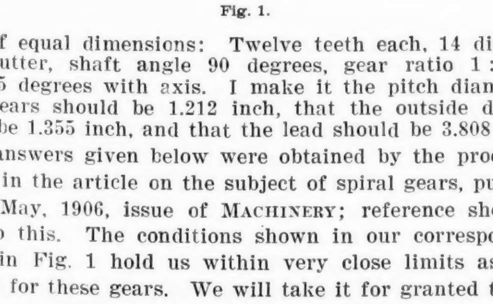


Fig. 1.

gears of equal dimensions: Twelve teeth each, 14 diametral pitch cutter, shaft angle 90 degrees, gear ratio 1 : 1, and tooth 45 degrees with axis. I make it the pitch diameter of these gears should be 1.212 inch, that the outside diameter should be 1.355 inch, and that the lead should be 3.808 inch.

The answers given below were obtained by the process described in the article on the subject of spiral gears, published in the May, 1906, issue of MACHINERY; reference should be made to this. The conditions shown in our correspondent's sketch in Fig. 1 hold us within very close limits as to diameters for these gears. We will take it for granted that the gears are to be made integral with the shafts on which they are mounted, otherwise they would merely be thin shells of no strength whatever. It is our object, then, to give them such pitch diameters that they will accurately fill the center distance given, and will be enough larger than the shafts of which they are a part to make it unnecessary to cut into these shafts when milling the teeth. The diagram for case No. 1, Fig. 2, shows these conditions fulfilled. This method of preliminary graphical solution requires that the ratio line for this case should be drawn at an angle of 45 degrees with the axis lines. The following dimensions have been worked out to fit the diagram, in accordance with the rules or formulas given in the article previously referred to:

	Gear on Large Shaft.	Gear on Small Shaft.
Number of teeth	12	12
Diametral pitch	18	18
Tooth angle	56° 10′	33° 50′
Pitch diameter	1.197 inch	0.803 inch
Outside diameter	1.308 inch	0.914 inch
No. of cutter used	No. 2	No. 5
Lead of spiral	2.521 inch	3.764 inch
Thickness of tooth	0.0873 inch	
Addendum	0.0555 inch	
Whole depth of tooth	0.120 inch	

The second case, of which a diagram is also shown in Fig. 2, may be given the same number of teeth and the same tooth

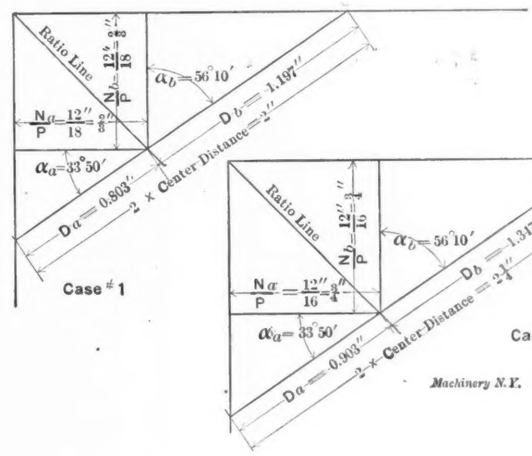


Fig. 2.

angles. This pair will in fact be merely that of case 1 on a slightly larger scale. The complete dimensions will be as follows:

	Gear on Large Shaft.	Gear on Small Shaft.
Number of teeth	12	12
Diametral pitch	16	16
Tooth angle	56° 10′	33° 50′
Pitch diameters	1.347 inch	0.903 inch
Outside diameter	1.472 inch	1.028 inch
No. of cutter used	No. 2	No. 5
Lead of spiral	2.836 inch	4.232 inch
Thickness of tooth		0.0982 inch
Addendum		0.0625 inch
Whole depth of tooth		0.135 inch

It is conceivable that you might have good reason for wanting the pitch in these teeth different or for wanting their diameters changed slightly, in which case it would be possible to get new solutions to accommodate the conditions desired.

The dimensions you have given for the 45-degree angle gears are correct.

* * *

A combination wood and steel railway tie has been invented by Mr. Thomas A. Galt, Sterling, Ill., which is claimed to have a number of superior advantages. The steel portion consists of two parallel channels, lying on edge, with the flanged sides in and separated by a distance of about 8 inches. Firmly clamped between the channels by four through bolts are two sections of ordinary wood tie, each about 2 feet long, 8 inches wide and 6 inches deep. The combination affords the same simple spiking condition as the ordinary wood tie and the same elasticity. Samples of these ties have been placed in the main line of the Chicago & Northwestern R. R., in Sterling, Ill. It is asserted that the facilities for tamping the ties with the open channel bar construction are superior to the ordinary wooden tie.

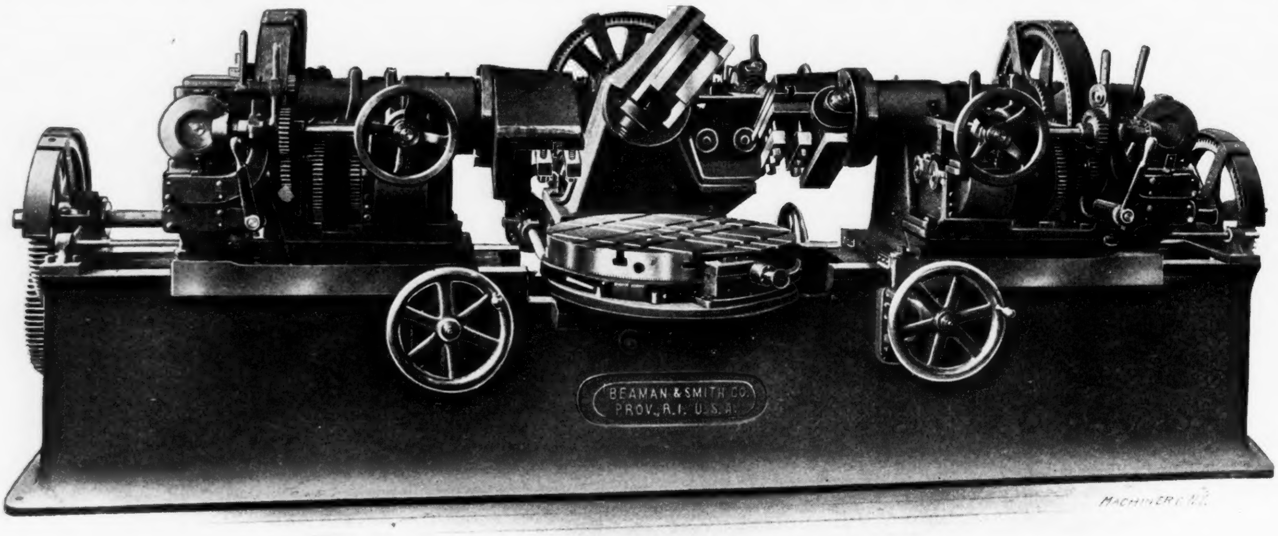
MACHINERY AND TOOLS.

A MONTHLY RECORD OF NEW APPLIANCES FOR THE SHOP.

BEAMAN & SMITH THREE-WAY FACING MACHINE.

The Beaman & Smith Co., of Providence, R. I., makes the machine shown in the accompanying halftone. It is used for facing one to three surfaces simultaneously on such work as valve bodies, cylinder castings, etc. It consists essentially of a circular work table which can be rotated to any angle, mounted on a bed carrying two oppositely disposing facing spindles, with a supplementary bed for a third facing head at right angles to the other two. All of the heads are driven by a single four-step cone and 4-inch belt through gearing which provides, in all, eight changes of speed of from 8½ to 40 revolutions per minute.

The circular work table, adjustable to any angular position, is graduated in degrees and has eight holes for stop pins.



Machine for Facing Three Surfaces Simultaneously.

Three surfaces may thus be operated upon simultaneously, and others may be faced at any angle in the same plane, means being provided to securely fasten the table in any position.

The in or out feed of the facing tools on the radial ways of the heads is effected by a feed screw, driven by a shaft passing through the center of the spindle, the arrangement being the same for each of the heads. By a patented construction the tool block may be adjusted by the operator by means of a hand wheel, this being possible whether the spindle is in motion or stationary. The feeds are 4, 8, 16, and 32 revolutions of the spindle to 1 inch travel, the ratio and direction being changed by means of levers conveniently located.

The machine will face to 28 inches in diameter. The least distance between the facers is 10 inches, and the greatest is 40 inches. From the center of the spindles to the top of the table is 15 inches. The weight of the machine is approximately 18,600 pounds.

FAY & SCOTT EXTENSION GAP LATHE WITH MOTOR DRIVE.

Fay & Scott of Dexter, Maine, have recently built a 24—46-inch extension gap lathe with motor drive, to meet government specifications. It is driven by a 5-horsepower Crocker-Wheeler motor with a 2 to 1 variation, through a silent chain drive to a sprocket on the spindle. The lathe is double back geared and is provided with a faceplate drive as well.

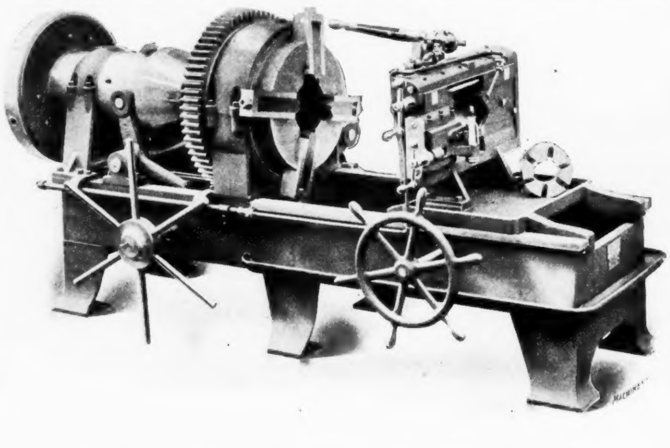
The general features of the builders' extension gap lathe are well known. A supplementary bed is adjustable longitudinally on the main bed. This may be moved up close to the headstock, when the tool is to all intents and purposes a 24-inch lathe. When it is desired to swing larger work up to 46 inches in diameter, the upper bed is moved backward until a gap of sufficient width is left to clear the work. The large faceplate may then be used with its direct drive for slower speeds. For large diameter work the extended cross slide is supported by a brace bearing on a finished way at the bottom of the bed. The fact that the width of the gap is adjustable, presents advantages obvious to any one who has use for a gap lathe.

A NEW DESIGN OF THE CINCINNATI LATHE AND TOOL COMPANY'S LATHE.

The 16-inch engine lathe made by the Cincinnati Lathe & Tool Co., Cincinnati, Ohio, may now be obtained in the double back geared style, with a three-step cone. This design is intended to meet the heavy duty required of modern machine tools. The lathe is provided with the W. T. Emmes' patent quick-change gear device, which gives forty positive-geared changes without alteration of the gearing. The back gears are of 3 1-3 to 1 and 9½ to 1 ratio, respectively.

BIGNALL & KEELER PIPE MACHINE.

The Bignall & Keeler Mfg. Co., of Edwardsville, Ill., has placed on the market a new pipe machine of a style and size designated as the "P. D. Q. C. No. 6," the suspicious looking



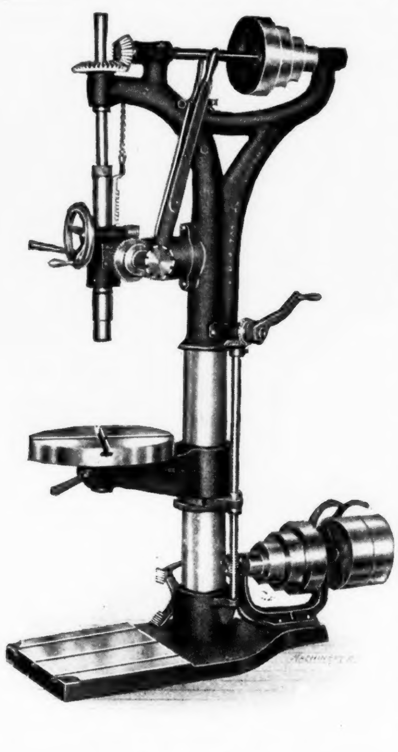
New Member of the Bignall & Keeler Line of Pipe Machines.

combination of letters used meaning nothing more serious than 'Peerless die—quick chuck." The chuck is operated by means of the pilot wheel shown in the cut at the head

end of the bed. The shaft on which this wheel is mounted carries a pinion meshing with teeth cut in the sector arm of the chuck lever, which operates the sliding cone encircling the spindle. As the cone is moved forward, the chuck arms, which are provided with rollers, run up on its large diameter, thereby tightening the jaws of the pipe. When the cone is moved back, springs draw the jaws away from the pipe. The jaws in the chuck are graduated and when once set for a given size no further adjustment is necessary for working with that size. A chuck is provided for the rear end of the spindle. This chuck has three independent jaws and is also provided with bushings for centering the work without gripping it. A four-step cone pulley and single back gearing gives eight changes of speed. The makers' well-known Peerless die head is used. This machine has a range of ten sizes of pipe, from 1¼ inch to 6 inches, inclusive.

THE SUPERIOR MACHINE TOOL CO.'S 21-INCH DRILL.

A new firm, the Superior Machine Tool Co. of Kokomo, Ind., is placing on the market the 21-inch upright drill shown in the accompanying halftone. It was designed by Mr. Albert E. Weigel, formerly superintendent of the Aurora Tool Works. It drills to the center of a 21-inch circle and will take 38 inches vertically between the base and the spindle, or 20 inches between the table and the spindle. The spindle has a feed of 8 inches, while the table is provided with a 16-inch vertical adjustment. A No. 3 Morse taper hole is used. The cone provides four changes of speed; the driving pulley should run at about 300 revolutions per minute. The net weight of the machine, which stands 6 feet high, is about 770 pounds.



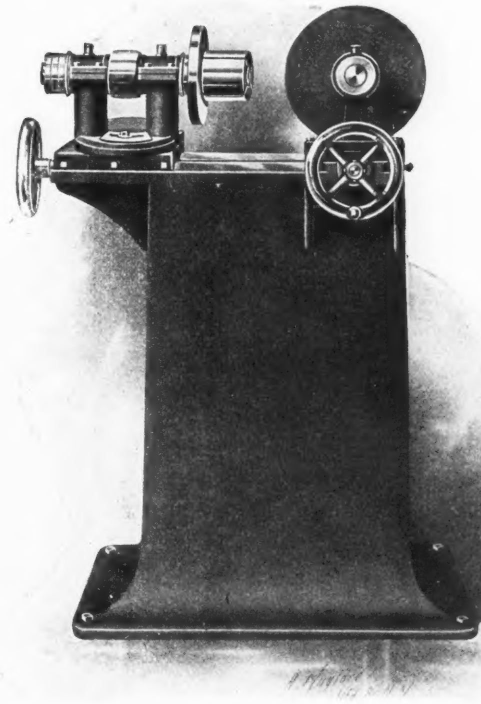
Superior Machine Tool Co.'s New Drill Press.

TWELVE AND TWENTY-FOUR-INCH ROCKFORD SHAPERS.

We have illustrated and described two sizes of the line of shapers built by the Rockford Machine Tool Co. of Rockford, Ill. These were the 20-inch, shown in the October, 1906, issue, and the 16-inch, shown in the November, 1905, issue. To this the concern has now added a 12-inch and a 24-inch size of the same general design. Among the strong points possessed by these tools might be mentioned the rigidly designed columns, high back-gear ratio, and carefully arranged system of control which places all handles and levers within reach of the workman on the operating side. The vise has an improved screw arrangement, such that the jaws are drawn and not pushed together, thus relieving the frame of strains which tend to spring it and impair its accuracy. Both the vertical and the cross feeds of the table are automatic and are driven by the same device.

A GRINDER FOR DISKS, PAPER SLITTERS, ETC.

This machine is built by the Bridgeport Safety Emery Wheel Co., Inc., of Bridgeport, Conn. It is designed for rotary face grinding of such parts as circular slitting cutters, saws, dies, punches, etc. The work may be held in a great variety of ways; a universal chuck is provided, but a Walker magnetic chuck may be used, or one of the plain 3- or 4-jawed type. The work may also be held on the revolving faceplate by means of an expanding arbor of the type shown, opened and closed by means of a screw. The work-carrying head swivels to any angle desired, thus enabling convex, concave or flat faces to be ground at either end of the spindle. The



Machine for Grinding Disks, Cutters, Etc.

head is mounted on dove-tailed ways gibbed to take up wear, and is fed in and out by handwheel and screw. Ring check nuts on the spindles take up all end play.

The machine is designed to be used either wet or dry. In the former case the wheel is enclosed with a hood, and pans are arranged to catch the water, which is returned to the large tank in the base where the dirt and sediment settles to the bottom, while the clear water is drawn from above by a centrifugal pump and forced back to the emery wheel and to the work being ground. The machine weighs about 500 pounds, has a faceplate 7 inches in diameter, and when the wheel is new, permits a distance of 6 inches between the platen and the wheel.

TWO NEW ARMSTRONG TOOL HOLDERS.

In Fig. 2 is shown a "3-bar boring tool" recently devised and placed on the market by Armstrong Bros. Tool Co., 113

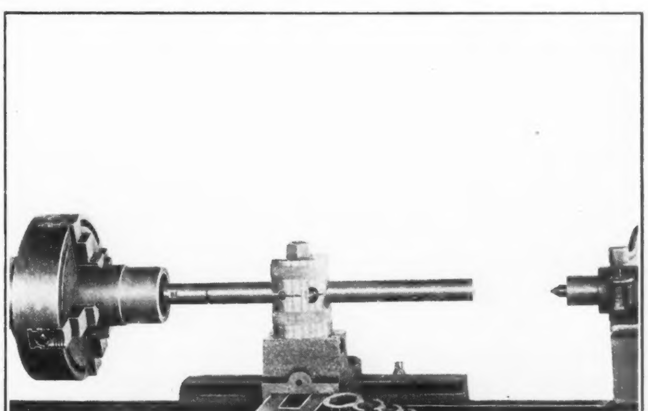


Fig. 1. Armstrong Boring Tool Holder in Use.

North Francisco Ave., Chicago, Ill. This combination of post and holder is made of bar steel throughout. The holder has a T-head fitting in the tool-post slot, to which it is clamped

by the nut at the top, which also serves to clamp the bars in place. Of these latter, as indicated by the name, there are three of different diameters. The fact that but a single turn of the wrench is necessary to release both the bar and holder, makes the change from one size to another a matter of seconds only, thus allowing the operator to use the stiffest bar possible for each job or each cut on the same job, with

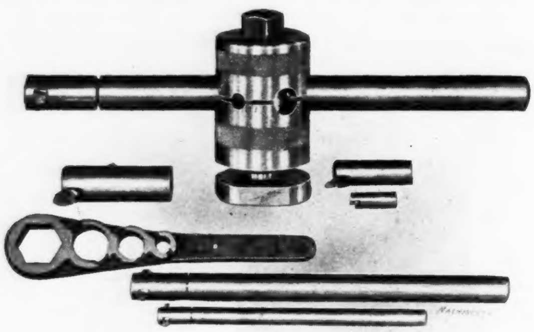


Fig. 2. Armstrong Three-bar Tool Holder.

the result that speeds and feeds can be increased and time saved. The wrench shown has one opening for the nut, and one each for tightening the cutters in the three sizes of bars furnished with the tool. The tightening of these cutters is effected in such a way that the pressure of the cut tends to hold them more firmly in position.

Fig. 3 illustrates an improved tool-post which combines in itself the strength and holding power of the strap and stud tool clamp, with the convenience of the open side and ordinary setscrew tool-posts. The construction will be apparent from the cut. It is made of drop forged steel throughout and consists essentially of a pair of jaws carrying tilting clamp-

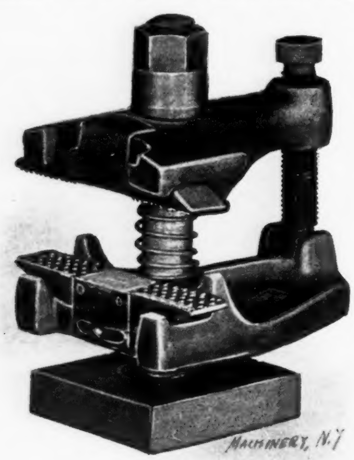


Fig. 3. Improved Tool Post.

ing faces; these jaws are pressed apart by a spring, and may be clamped together by the T-head bolt which passes through them and into the slot of the tool-block. A knurled head adjustable screw furnishes the rearward support for the clamping action.

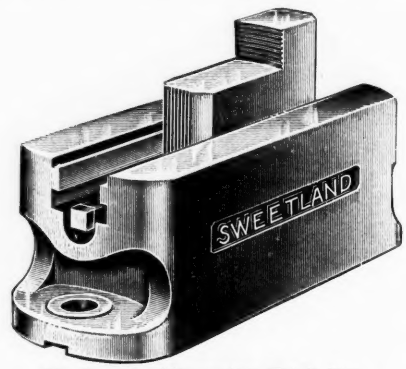
This tool-post is claimed to be stronger and stiffer than the ordinary type, will not slip or allow the tool to chatter and will consequently do more work. It will work up close to the chuck and has a great range of adjustment without loss of holding power, the jaws adjusting themselves on parallel lines; the open side permits rapid change and adjustment for tools; it will not cut or tear the tool shank and thus is particularly adapted to use with tool holders, and no trouble is possible from stripped or upset screws. By using V-blocks fitted to this tool-post, boring bars and similar tools of various diameters can be conveniently held.

IMPROVEMENTS IN THE DELPHOS OIL PUMP AND TANK.

In the February, 1906, issue of MACHINERY, we illustrated and described a non-overflowing pump and tank made by the Delphos Mfg. Co., Delphos, Ohio. This tank is arranged to fill with oil any sized receptacle brought to it, and return the excess to the reservoir in the base without allowing it to overflow. A double spout is used, one branch supplying the oil and the other returning the excess. As originally arranged, the device was used for handling the lighter grades of oil. Recent improvements, however, have made it possible to use the non-overflowing arrangement with the very heaviest liquids the tank will be called upon to carry. The 10-gallon size is a very popular one for factory use. Its portability is especially convenient where the keeping of lubricating oils in the factory increases the risk in the eyes of the insurance inspectors. The sales of this device have greatly increased during the past year and numerous re-orders have been received.

IMPROVED SWEETLAND FACE-PLATE AND JAW.

The accompanying cut shows a chuck jaw of the individual type, designed to be fastened in position on the face-plate of a lathe, boring mill or other machine of a similar nature. It



The Sweetland Face-plate Chuck Jaw.

is composed, as may be seen, of a rugged base casting, a hardened jaw, and an adjusting screw. The device may be used either way about, for holding work by the outside or by the bore. This device is manufactured in three sizes by the Hoggson & Pettis Mfg. Co., New Haven, Conn.

THE IMPERIAL AIR MOTOR HOIST.

The objectionable, and often prohibitory, features of the direct-acting air hoist are sufficiently familiar, and these are all conspicuous by their absence in the Imperial air motor hoist here shown. It does not require a great height above

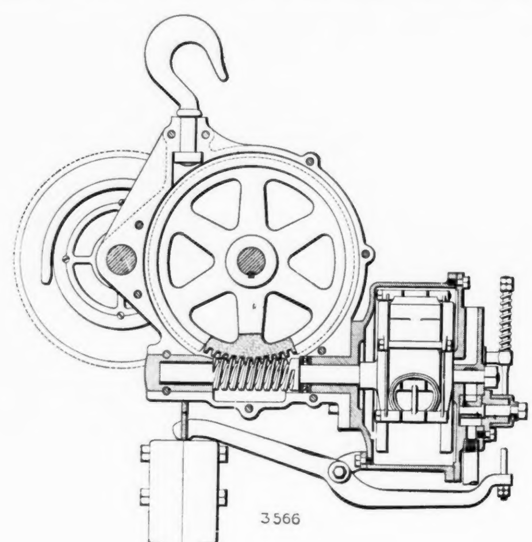


Fig. 1. Section of Imperial Air Motor Hoist.

the lift, and no more height for a high lift than for one not so high. The movement is perfectly controlled both for hoisting and lowering and the load is absolutely held at any point desired. There is no waste of air in filling long cylinders,

the amount used at any time being only that required for the actual work.

The motor is a positive-action reversible air engine, with no dead centers and a practically uniform torque. It has no delicate valve mechanism requiring adjustment or liable to get out of order. It is wholly enclosed, dust-proof, splash oiling, with every bearing bushed, and bathed in oil. The steel worm on the motor shaft runs in an oil pocket; its thrust is taken by a roller bearing; it meshes into a worm-wheel of bronze, a pinion on the worm-wheel shaft engaging the drum shaft gear. On the larger sizes of hoist there is an additional speed reduction; on all sizes the friction is the least possible, being minimized by the juxtapcsition of suitable materials and by careful workmanship. The hoisting rope under-runs a sheave, which always permits an exact equalization of the two sides on the drum. The hook turns on ball bearings, so the load may be turned in any direction without twisting the ropes and without its turning back. The action is steady and smooth, twelve of the hoists being used for the delicate work of hoisting flasks in one foundry alone. The hoist is made in five sizes with capacities ranging from 1,000 to 10,000 pounds, using the ordinary air pressures. It is built by the Ingersoll-Rand Co., 11 Broadway, New York City.

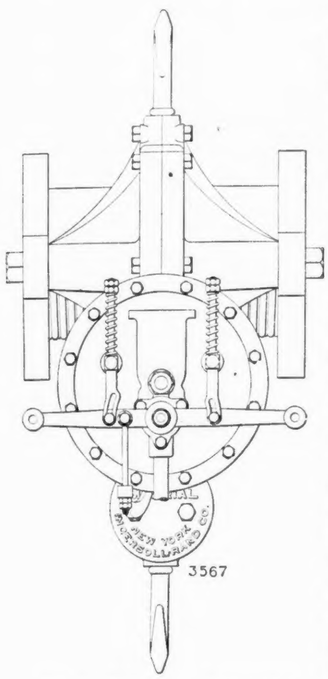


Fig. 2. End View of Imperial Motor Hoist.

THE THOR PNEUMATIC DRILLS.

In Figs. 1 and 2 are illustrated two of the "Thor" pneumatic drills made by the Independent Pneumatic Tool Co. of Chicago and New York. That shown in Fig. 1 is non-reversible.

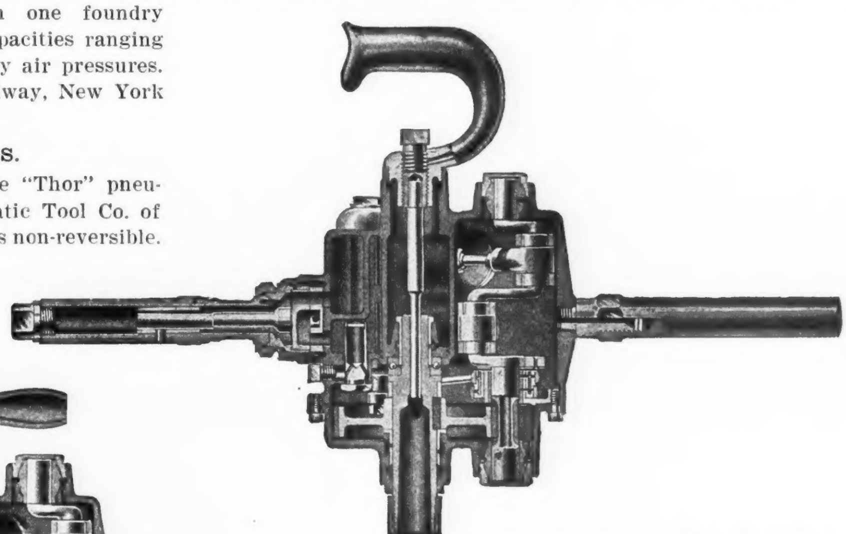


Fig. 2. Drill Similar to that shown in Fig. 1, but Reversible.

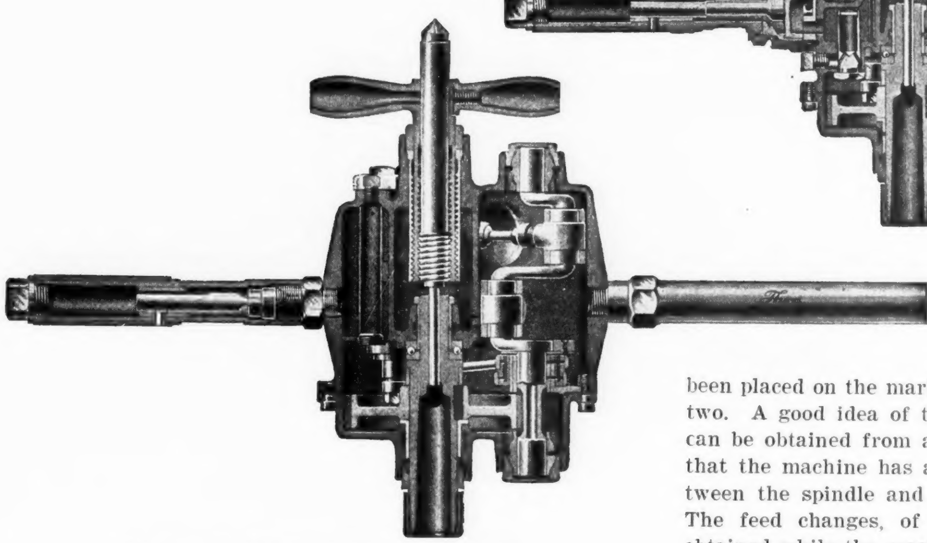


Fig. 1. The Thor Non-reversing Pneumatic Drill.

There are four single-acting cylinders in the body of the drill. The admission of air to these cylinders is controlled by Corliss valves immediately adjacent to the cylinders. These valves are operated from one double eccentric, which is provided with individual bearings independent of the crankshaft or of any other working part of the motor. This eccentric is driven by spur gearing. The crankshaft bearings are placed close to the crank, giving a saving in total length of the motor equal to the length of the eccentric. The feed is telescopic. An externally threaded stud works through an internally threaded sleeve to the extreme limit of its travel, and then the sleeve in turn screws out of the holder an equal distance, giving an unusual length of feed in an unusually short over-all height.

The motor is very accessible. By removing the exhaust caps, either valve may be removed without disturbing any part of the motor. The pistons may be removed by unscrewing the cylinder head, while the connecting rods may be taken out through the cylinder bore. The case of the motor is made with but one joint. The cylinder and gear case are steel castings, while all the other wearing parts are either steel forgings or are cut from solid steel stock.

The reversible drill shown in Fig. 2 is of the same general design as the non-reversible, except that the device for admitting air to the cylinders is arranged to cause the drill to rotate in the opposite direction when desired. This is done by a simple two-way valve placed in the admission chamber at the inner edge of the inlet pipe at the left of the illustration. This valve, when desired, sends the air through the exhaust port into the valve chamber and thus into the cylinders, instead of by the usual route. In both machines the controlling valve is placed close to the cylinders, so that the machine responds instantaneously to the movement of the valve.

These machines are made in fifteen sizes and are adapted to all classes of drilling, reaming, tapping, flue rolling, wood boring, etc. The manufacturers will send a machine on approval to any responsible person or firm desiring to try one.

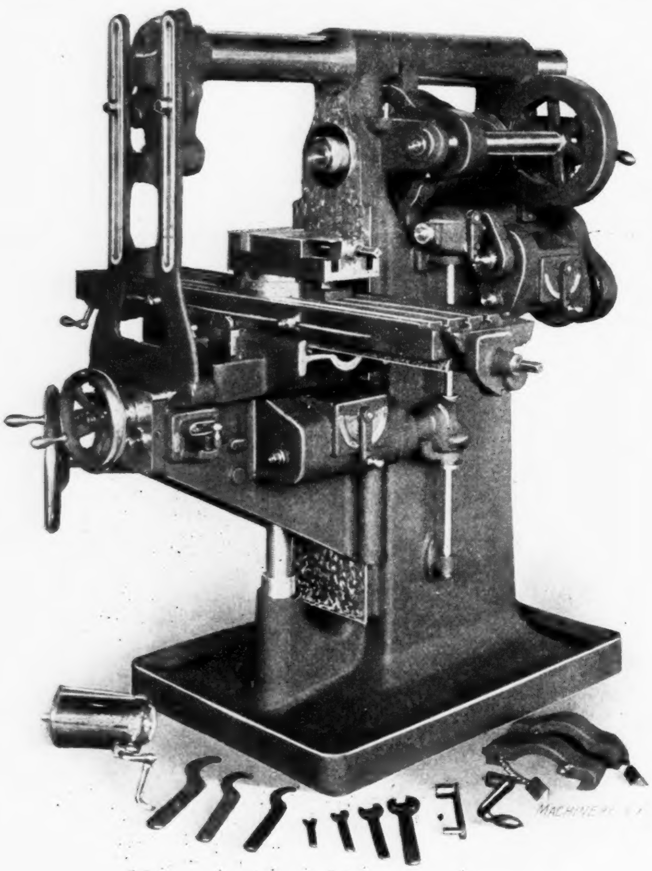
OWEN PLAIN MILLING MACHINE IMPROVEMENTS.

The line of plain millers built by the Owen Machine Tool Co. of Springfield, Ohio, has recently been remodeled. Two sizes of this new line, known as the No. 2-B and No. 3-B, have been placed on the market; the cut shows the smaller of these two. A good idea of the stiffness and rigidity of the design can be obtained from a study of this cut. It will be noticed that the machine has a geared feed, no chain being used between the spindle and the feed screw, as in former models. The feed changes, of which there are thirty-two, may be obtained while the machine is in motion without the slightest injury to the working parts; the handles for controlling these changes are always in easy reach of the operator, and the feeds are automatic in all directions. The usual telescopic drive is eliminated, being replaced by vertical and horizontal shafts and sliding bevel gears.

The table has a double bearing, being fitted both above and below the dovetailed slide. This tends to keep it in good alignment even when working at the extreme of its motion, at the same time preventing it from cramping, and thus allowing it to work freely. All the gearing throughout the machine

is of steel. The spindle is of crucible steel, running in phosphor bronze boxes provided with means of compensation for wear. The back gears are single in the machine shown, and double in the No. 3-B size, giving respectively 12 and 18 changes of speed with three-step cone and two-speed countershaft. The overhanging arm is of solid steel, carrying an arbor support lined with a bronze bushing.

For the No. 2-B machine shown in the cut, the longitudinal movement is 28 inches; cross feed, 7½ inches; vertical feed 19½ inches. The largest diameter of the cone is 11⅞ inches and it has four steps for a 3-inch belt. The spindle is bored for a No. 10 B. & S. taper. The net weight of the machine is 2,850 pounds. The dimensions for the No. 3-B machine are as follows: Longitudinal movement, 38 inches; transverse



No. 2-B Owen Plain Milling Machine.

movement, 11 inches; vertical movement, 20¾ inches. The largest diameter of the cone is 12"7-16 inches for a 3½-inch belt. The spindle is bored for a No. 11 B. & S. taper. The net weight of the machine is 4,300 pounds.

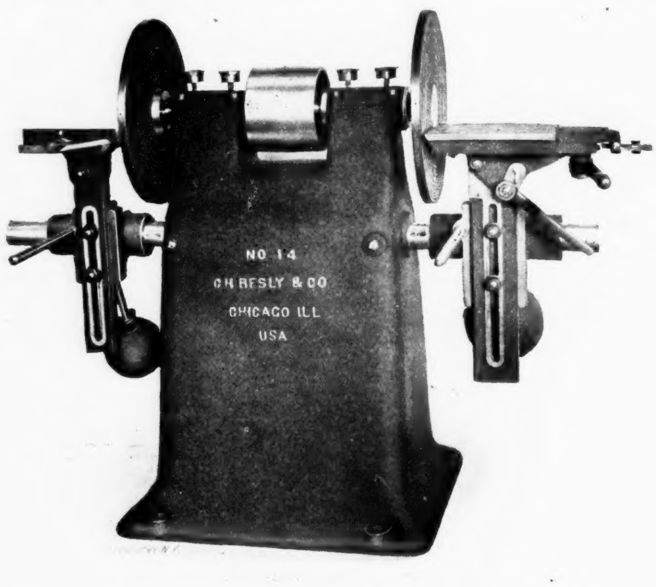
BESLY SPIRAL DISK GRINDER NO. 14.

The disk grinder shown in the cut is built by Charles H. Besly & Co., 15-17-19-21 S. Clinton St., Chicago. This tool is a recent addition to their extensive line of disk grinders. It is a heavy, rigid machine, equipped with lever feed table and strong belt drive, adapted to grinding work in manufacturing quantities. The construction is on a par with that of high-grade machine tools.

The lever feed table bed has T-slots and a key-way for attaching angle plates or other work holders. The table is mounted on a gibbed dovetail slide, and is moved to and from the disk by a lever, pinion and rack, which gives a leverage of 14 to 1. This is a desirable feature as it enables the operator, without undue exertion, to turn out more work by using the abrading disk at its maximum efficiency. The table is equipped with a micrometer stop screw, graduated to read in thousandths of an inch.

The bearing bushings and rocker shaft are turned on the outside, and carefully fitted into bored and reamed holes in the main casting. The end thrust of the spindle is taken between the cast-iron spindle pulley and the flanges of the bronze bearing bushings, on hardened and ground steel collars of large area. The left-hand table carries a detachable bevel gage graduated to 45 degrees. Both tables may be tilted from their horizontal position, and have vertical adjustment and rocking motion, with adjustable counterweights.

The disk wheels are 20 inches in diameter by about 13-16 inch thick, but the machine will swing 23-inch wheels. The

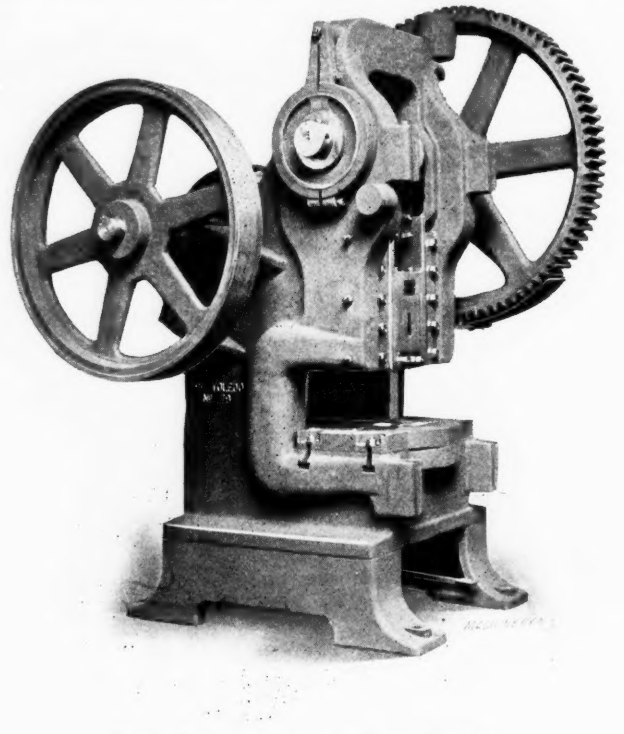


Besly Spiral Disk Grinder.

spindle pulley is 9 inches diameter for a 7-inch belt. The spindle is 2 inches diameter with phosphor bronze split bearings 9 inches long. The rocker shaft is 2¾ inches diameter. The machine, with countershaft and floor press, weighs about 3,000 pounds.

A GAP PATTERN PRESS FOR HEAVY BLANKING.

Large blanks or disks of heavy plate are now being produced in such large quantities that single rotary slitting shears with circling attachments, formerly used for making these disks, are being replaced by presses and blanking



Toledo Gap Pattern Press for Heavy Blanking.

dies. The dies for this work require powerful presses with unusually large bed area and opening. The accompanying illustration shows the design of a new size of geared press with a capacity for cutting large blanks of steel plate up to ⅜-inch; the machine has recently been placed on the market by the Toledo Machine & Tool Co. of Toledo, Ohio. It is much better adapted to the class of work described than the solid back or

other types of press formerly used, and which necessarily had a very limited bed area and opening. The gap pattern is desirable for the convenience of the operator in feeding the heavy plates or bars from which the blanks are made.

This machine has a driving pulley 2 feet in diameter for a 6-inch belt. The balance wheel is 62 inches in diameter and weighs about 1,300 pounds. The gearing reduction is 7½ to 1, the large gear being 61 inches in diameter. The stroke of the particular machine shown is 2 inches, but this can be changed to suit conditions; an adjustment of 4 inches is provided. The distance from the top of the bed to the face of the slide, with stroke and adjustment up, is 13 inches. The bed is 28 inches wide, front to back, and 36 inches long, right to left, with an opening 24 inches wide between the side housings of the frame. The gap extends 8½ inches back of the center line of the slide. The machine weighs about 18,500 pounds.

PORTABLE BORING BAR FOR STEAM TURBINE WORK.

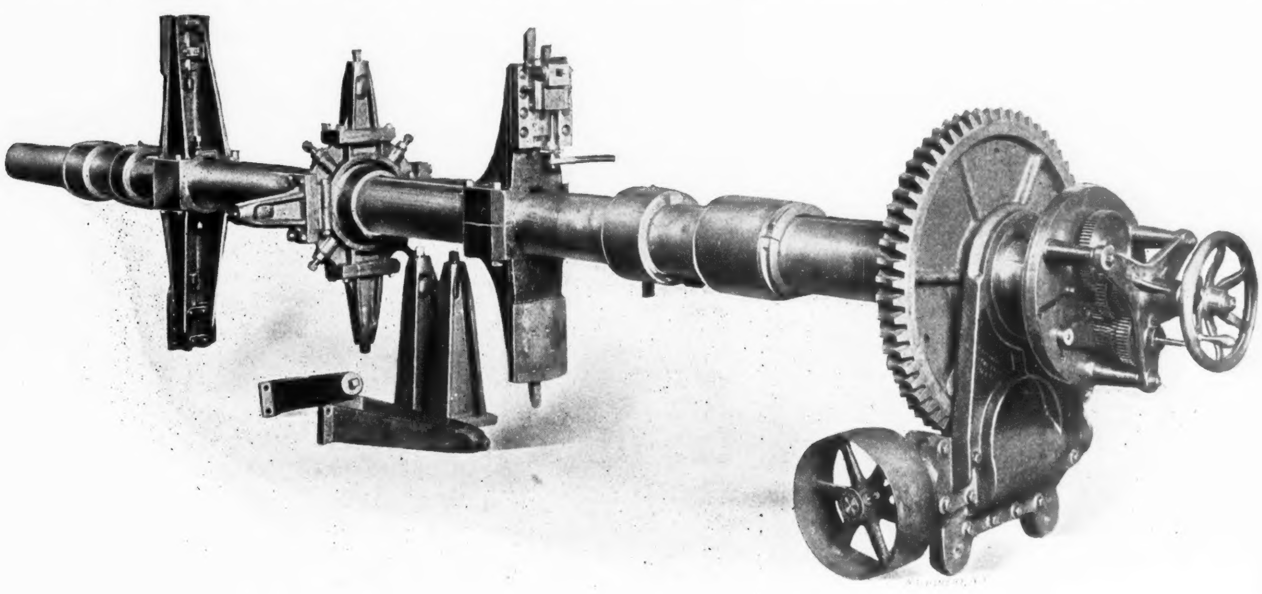
The portable boring bar here described is unusual, in the first place, in the matter of size, though this does not show plainly in the cut on account of the absence of anything with which to compare it. This tool is made for boring up to a diameter of 10 feet, and the bar is 27 feet long. The work for which it is intended is the finishing of the inside surfaces of steam turbine casings or cylinders.

In the process of construction, these castings are first machined at the joint and put together. The shaft openings are then rough bored, the flanges are faced, and the whole thing fastened solidly together, forming a long cylinder to be finished on the inside in a series of varying steps or internal diameters. The bar is inserted through the shaft openings of this long cylinder and carefully centered, being supported by suitable adjustable bushings at these points. Through a manhole in one of the castings the operator now enters and arranges the required boring members and center supports in the interior. These parts are necessarily made in sectional form to permit their being passed in and out through the manhole, and to allow them to be easily handled by the workman. The halftone shows a central support and two boring heads mounted on the bar. The central support has four removable arms, various lengths being used for various diameters; extra parts for this are seen on the floor beneath the machine. The boring heads are made in halves and are arranged to carry two tools diametrically opposite to each other.

In turbines of the type for which this tool is designed, several grooves for the insertion of blades are required to be cut around the circumference of each step in the cylinder. For cutting these grooves, use is made of a supplementary sliding head shown on the upper end of the boring head nearest the right. On the lower end of the same cutter head is shown a place to attach a grinding wheel if necessary, this being used in some cases to finish the blades after they are inserted in the grooves. Finishing boring cuts are also taken by this tool over the blades after they are assembled in the casing. All of the cutting tools for these operations are fastened in place and adjusted by the workman while inside of the casing.

The bar is rotated by an accurately cut worm and wheel of the Albro-Hinley type. The longitudinal feed for the heads is obtained from a screw set within a slot cut in one side of the bar. A similar slot on the other side carries a key, which takes the strain of turning the bar, this strain being in no degree transmitted to the feed screw. The feed screw is rotated by the gearing shown at the head end; three changes may be obtained by operating a push pin. Feeding is accomplished by blocking the hand wheel shown, in any convenient way, the hand wheel serving as well for manual operation of the feed screw.

With the increase in the use of the floorplate method of doing heavy work and with the increase in the size of engine and electrical machinery parts, the use of special portable tools has greatly increased. This tool is one example of a number of special devices which H. B. Underwood & Co. of 1025 Hamilton St., Philadelphia, Pa., have been called upon to furnish for engineering establishments engaged in heavy work.



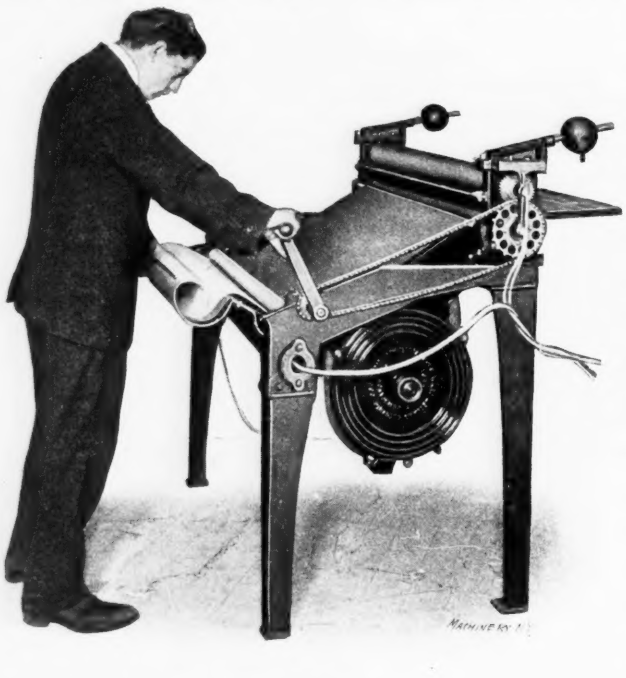
Underwood Portable Boring Bar for Steam Turbine Work

THE CRABB TRANSPARENTIZER.

In the May, 1906, issue of MACHINERY we described a transparentizing machine built by Chas. L. Crabb & Co., 115 Nassau St., New York; this machine was designed for rendering pencil drawings on ordinary drawing paper transparent enough to be used for making blueprints. The cut herewith shows an improved form of the device. It may be operated much more rapidly than the first machine, and has a greater capacity, permitting of the treatment of drawings 42 inches wide and of any length. It will take any thickness of white paper upon which drawings or writing have been made with a pencil or any other ordinary erasable material, and by means of a hot chemical bath and heated calendering rollers render it permanently transparent and waterproof. This operation is a matter of a very few moments only, and from the paper thus treated blueprints can be made immediately, thereby saving the time, labor and expense involved in preparing drawings for blueprinting by the present methods.

A tray which forms a part of the machine contains the solution to be used; this is heated by an electrical resistance coil, wound for 110 or 220 volts. The drawings to be treated are fed into the rolls of the machine and passed through this heated bath by the turning of the crank. After leaving the

bath the sheet is carried by a traveling fireproof apron to heated calender rolls, which squeeze out the surplus liquid, giving the sheet a smooth and dry surface. The operation of the transparentizer is extremely simple and requires no preliminary training or knowledge. It can be operated by a



The Crabb Transparentizer.

boy, at an approximate total cost of two-tenths of a cent per square foot. A saving of 35 per cent in the cost of drawing-office operation is claimed.

* * *

REISSUING DEFECTIVE PATENTS.

The Court of Appeals of the District of Columbia has just rendered a decision which overthrows the views expressed in standard textbooks on patent law, and which should establish a more liberal principle in the reissuing of patents in the future. The statute relating to the reissue of patents has been for the past twenty years construed rather strictly by the Patent Office, so that patent attorneys have looked upon reissues as possible only in the rarest cases. In the present case the applicant was a Frenchman, unfamiliar with American patent law, and not having direct communication with his American patent attorneys. The result was the taking of a patent in this country, which, while it gave to the world a knowledge of a very broad invention—a new and valuable process of melting steel in an electric furnace—did not secure to the inventor the reward which the law contemplates. The patent was limited to a detail of the furnace, and the broad idea of a new process of working the furnace was not claimed. Upon an application for reissue of this patent so as to secure to the inventor claims for the process which he had invented, the three successive tribunals of the Patent Office through which the case was prosecuted refused the reissue, chiefly on the ground that where the patent was originally taken for an apparatus it could not be reissued with claims for a process. This was a theory which had been enunciated in textbooks for a number of years past, and had been held by the Patent Office and apparently acquiesced in by inventors. The present case was appealed, and a decision rendered by Chief Justice Shepard reversing the decision of the Commissioner of Patents, and allowing the reissue with the broadest claims. The court took the view that since the process was described in the statement of the invention of the original patent, although not specifically claimed, the patent might be reissued for the purpose of inserting the claims inadvertently omitted.—*American Industries.*

* * *

Some people are so afraid that a competitor will learn about their business that we sometimes wonder that they sell any goods at all.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH ENGINEERING ACTIVITIES.

Over here there is little change in general conditions. The electrical industries are somewhat hampered by lower prices prevailing, especially in view of the higher prices for raw materials. Manufacturing plants have so multiplied and have been equipped on such modern lines that the competition for electrical contracts of any magnitude is increasingly keen throughout Europe. A number of the smaller concerns which have carefully and gradually extended their operations and equipment appear able, without extreme inconvenience, to compete in several departments with the larger plants at the low prices ruling. In the matter of British industrial organization and methods an interesting departure is to be noted. The employes of the Bradford Dyers' Association recently applied for a 10 per cent advance in wages. As a large volume of business at remunerative prices was being dealt with, it was decided to grant the advance if certain rearrangements of methods—involving a diminution in the number of men employed per unit of output—would be accepted by the workmen. After considerable discussion, the employers' proposals, somewhat modified, were agreed to, on condition that during the first year's operation of the new scheme the proportion of men discharged should not exceed 5 per cent of the number now employed, and that the employers should pay out-of-work benefits to the discharged men at the same rate, and, if necessary, for the same length of time, as paid by the trade union, thus doubling the length of time an unemployed member would be entitled to assistance. This basis of settlement will probably again be heard of in trade disputes touching other industries where improved machinery involves a smaller working force, it being felt that the consequent hardships to the displaced laborers should receive specific consideration during the period of readjustment of working conditions.

Considerable attention is now being paid to the requirements of British commercial men by the board of trade and the consular departments, and important improvements with regard to the methods of supplying prompt and direct information as to foreign markets and requirements, to British manufacturers and merchants, are under way. The question of the compulsory working in Great Britain (either by the patentees or licencees) of patents granted to foreigners is also receiving the careful consideration of the government. In the past the incidence of the present laws, or their administration, has tended to produce a virtual foreign monopoly in certain lines, a quite opposite result to that contemplated by the framers of the law.

Our universities, leading manufacturers and chambers of commerce are now working together much more frankly than formerly with a view to the encouragement and utilization of latent talent. As an instance may be mentioned the "Gartside" scholarship at the Victoria University of Manchester. This, founded in 1902 by a Manchester manufacturer, is open to British subjects of eighteen to twenty-three years of age and is tenable for two years. The first year's work at the university is designed to preface the student so that he may usefully investigate some industry, or part of an industry, in the United Kingdom or abroad. The investigation itself occupies the second year, and to smooth the way the value of the scholarship, which is about $400 per year for time spent in England, is increased to $750 a year for time on the Continent and $1,250 for the United States. An interesting report by the present holder of the scholarship on industrial matters in the United States was recently issued. The matter of location of manufacturing plants receives increasing consideration. Though so comparatively small, the United Kingdom has areas of such diverse character and accessibility by rail or water that periodical surveys of the question of suitable location are desirable. Some inland concerns interested in heavy iron and steel manufactures tend to remove to the seaboard, where possible, in order to diminish the cost of carriage of raw and finished materials—an important item in the total cost of production and marketing. As one of the latest instances in this connection, may be mentioned Cammell, Laird & Co. of Sheffield, who are investigating the

potentialities of Swansea for the establishment of branch works. The opening and working of the Manchester ship canal has also opened out another important industrial district which offers advantages in the way of facilities for handling of railway, barge canal and sea-borne traffic, coupled with a good supply of skilled labor and close proximity to probably the most compact group of manufacturing towns and localities in the world.

A branch of engineering which does not obtrude outside a limited sphere, in which, however, it plays a by no means negligible part, is that of the design, construction and working of modern coke ovens. Our German friends gave a notable lead in the matter of coke-making processes carried out with a view to recovering and utilizing products of distillation formerly practically wasted. These by-products are of considerable commercial value, and though one hears statements that the value to the foundryman of the coke produced by the new process is thus impaired, a shrewd guess may be made that the requirements of the consumers of the coke or by-products will be catered for in proportion to the respective profits accruing from the two products. Some important installations of these coke ovens have been carried out in Great Britain by the firm of Simon-Carves, Ltd., of Manchester, who also undertakes to afterward run the plants, if considered desirable. A kind of side line of this business is the design, erection and supervision of crematories, the company having been pioneer in this direction.

Somewhat allied to this class of work is the design and installation of modern refuse destructors, which are now recognized as pretty well essential to efficient sanitation. The present theory is to, without nuisance, at once destroy all organic matter by exposure to extreme heat—generated by the combustion of the refuse—and thereby raise steam, which is utilized for various purposes, including sewage and water pumping, driving clinker-crushing and mortar-making machinery, generating electricity, etc. As a residual, a vitreous clinker, which is a marketable article in good demand for roadmaking, bacterial sewage filter beds, etc., is produced. The percentage of combustible matter in town refuse varies considerably, being low in country districts where coal is expensive, and comparatively high in manufacturing districts where the domestic use of fuel is, perhaps, somewhat wasteful owing to the English system of open fireplaces. In a number of cases it is found that 1½ pound of water can be evaporated per pound of refuse. In order to obtain such results, the air forced under the fire-bars is preheated by being drawn through regenerator tubes, the outsides of which are in contact with the highly heated gases from the furnace cells on their way to the chimney stack. The feed water for the boilers is also heated by economizers also utilizing the waste gases. In the town of Preston about 1,000 horsepower is daily produced by the destruction of the town's refuse, no nuisance being caused. A good share of the current for running the municipal tram cars is thus provided in addition to the lighting of several administrative buildings. Destructor plants have been erected in many British cities, several on the Continent and in the colonies, and a few, from British designs, in the United States. Concerns prominent in this line are Meldrum Bros., The Horsfall Destructor Co., Heenan & Froude and Manlove Alliot & Co. Messrs. Heenan & Froude, Ltd., Manchester, England, have been commissioned to erect a destructor on Staten Island, New York, to deal with 60 tons of refuse per day of 24 hours, boilers to utilize all the heat generated being also installed.

A rather curious feature in the underground communications of London and New York is the fact that the electrification of the London Metropolitan Railway was carried out by Americans through the instrumentality of Mr. Yerkes, as British electrical engineers found the task too big for them at the time, while the subways under the Hudson are being driven by a British firm of engineers and contractors who, through their unique experience in the utilization of compressed air for tunneling operations, are in a position to effectually cope with the difficulties encountered through the leaky strata of the river bed. JAMES VOSE.

Manchester, February 18, 1907.

MISCELLANEOUS FOREIGN NOTES.

ALFRED HERBERT, LTD., Coventry, England, has built an automobile engine valve grinding machine in which the valve is rotated continuously in one direction and periodically lifted from its seat, while grinding, by a vertical spindle in the table which is connected to the belt pulley by a crank motion.

LOUDON BROS., LTD., Johnstone, England, have recently completed a horizontal boring and facing machine of large proportions. The bed is 16 feet long; the boring bar, 4 inches in diameter, has a travel of 2 feet 9 inches, and its maximum and minimum distances from top of the two tables of the machine is 24 inches and 6 inches respectively. The machine is built primarily for railway work, and is made to order only.

MOTOR CAR INDUSTRY IN GREAT BRITAIN.—During the last year the motor car industry has assumed great dimensions in England, there being at present more than $60,000,000 invested in the British motor car companies, and the value of British cars manufactured during 1906 exceeding $20,000,000. The trade gives employment to a quarter of a million men. The excellent character and popularity of British cars is indicated by the fact that the import of foreign cars decreased during the year by nearly $400,000.

GERMANY'S EXPORT AND IMPORT OF MACHINE TOOLS DURING 1906.—According to *Zeitschrift für Werkzeugmaschinen und Werkzeuge*, the import of machine tools to Germany last year amounted to 8,574 tons, of which 5,742 tons came from the United States. The exports amounted to 45,241 tons. The imports were nearly 50 per cent larger than those of 1905, and the exports nearly 40 per cent larger than in that year and nearly double those of 1903. Germany's best customers are Italy, Austria and France; Russia, Belgium and Switzerland come in the next place.

MESSRS. DRUMMOND BROS., LTD., Ryde's Hill, England, have recently designed a small 5-inch lathe intended for repairs on motors and motor cars. This lathe is made with considerable accuracy, and high claims are made for it in regard to capacity and power. This lathe differs to a great extent from the usual design of lathes, being at the same time a miniature boring machine with a table similar to that of a Lincoln milling machine. Special features of the lathe render it available for an infinity of operations which could otherwise not be performed without a great number of machines.

MESSRS. LUDWIG LOEWE & CO., LTD., Farringdon Road, London, have introduced a new drill chuck called the "Grip" chuck. The construction of this chuck is such that the greater the pressure on the point of the drill, the more positive the grip of the chuck. In actual tests, half-inch drills made of high speed steel have been driven with feed and speed resulting in the total collapse of the drill without causing the shank to turn in the chuck. There are no gears or screws in the construction of the chuck, and no key is employed to move the jaws; for this reason it seems as if the makers' claims as to the durability and convenience of the chuck are well founded.

MESSRS. BUTLER & CO., Halifax, England, are building an interesting turning and facing machine. This machine is intended for finishing flywheels at one setting, that is, for turning the face, the rims, the inside and outside of the hub and boring the holes, six tools being in operation at once. The headstock and tool-rests are mounted on a heavy base plate. The face-plate is supported by roller bearings in the headstock. There are six changes of automatic feed. The drive is engaged and disengaged by friction devices. The driving cone and gearing are all designed to give uniform gradations of speed and power. This machine will turn flywheels up to 10 feet diameter and 21 inches wide. The floor space is 22 feet 6 inches by 17 feet.

AUTOMOBILE EXPOSITION IN GERMANY.—The International Automobile Exposition in Berlin last winter was one of the greatest successes ever attained in this line in Germany. Three hundred and seventy-one firms and manufacturers exhibited their products. Of these 338 were German, while other exhibits were from France, Italy, England, United States, Belgium and Switzerland. Besides automobiles, machines for

the production of automobile parts were exhibited, and Schuchardt & Schütte, of Berlin, exhibited a fine collection of American lathes, screw machines, milling machines, grinding machines, etc., from well-known American firms, among which were the Cincinnati Milling Machine Co., Landis Tool Co., and the Cleveland Automatic Machine Co. There were many motor vehicles of various types for industrial and business purposes exhibited, but considering the great importance of this branch of the automobile industry, a much larger exhibition might have been expected. The reason assigned is that nearly all manufacturers in Germany who are in a position to deliver vehicles are so overcrowded with orders for touring cars, on which they are able to realize a much greater profit than on cars for business purposes, that the latter receive only secondary consideration. The inclination of the manufacturers toward standardizing their motors and the construction of the same in large quantities, together with the fact that new plants are rapidly springing into existence, will probably soon effect a change in this condition of affairs.

THE MACHINE TOOL BUSINESS IN FRANCE.—France has not as yet devoted its energies to any great extent to the manufacture of machine tools, and in its many varied industries it uses mostly American and German machines. The imports from the United States are constantly increasing, but there are some complaints in regard to slow delivery and insecure packing. The German trade in France in regard to machine tools is also increasing rapidly, due to the thorough preparation of the German salesmen before they go out "on the road," particularly when they are going to foreign countries. A German salesman gets not only a thorough shop experience, but he is also expected to be well grounded in the principles of machine design, to have worked as an assistant to the inspector testing machines before shipping, and then, if sent to a foreign country, to be thoroughly familiar with the language of the country to which he is sent. The German machine tool builders print their catalogues in several languages, realizing that their own tongue cannot always be depended upon to be understood by the persons whom they want to reach by their trade literature. These points have been accentuated by special agent Arthur B. Butman and may be worthy of consideration. Small tools are manufactured in France and are sold at a lower price than the American-made tools. The latter, however, give better satisfaction and have a good market, the only complaint being of the slow delivery.

* * *

OBITUARY.

R. W. Fuller, the inventor of the machine for making horseshoes, died March 11 at Hanover, Conn., aged 85 years. It is claimed that Mr. Fuller's invention was copied by others who made millions of dollars through it, but the inventor died a poor man.

O. D. Munn, one of the two original publishers of the *Scientific American* in its present form, died February 28 at his home in Llewellyn Park, Orange, N. J., aged nearly 83 years. Mr. Munn and his partner, A. E. Beach, who died about eleven years ago, acquired the *Scientific American* in 1846 and made it the organ of their patent business which grew to great proportions, over 100,000 patents having been taken out through this firm alone. The profession of the patent lawyer sixty years ago was nearly unknown, and the concern was, in a sense, a pioneer. The work of the partners brought them in intimate contact with many of the famous inventors of the past era.

HARRY C. HOEFINGHOFF.

Harry C. Hoefinghoff, president and general manager of the Bickford Drill and Tool Co., Cincinnati, Ohio, died on March 2 from an operation performed a few days earlier for appendicitis. Mr. Hoefinghoff was thirty-five years of age, and had been president of the company since 1899, when he succeeded his father, who was also one of the owners of the Hoefinghoff & Lane Co., an old-time Cincinnati foundry business. Mr. Hoefinghoff was one of the leading young business men of Cincinnati, but his acquaintance was not confined to that city, being extended over the entire country, especially among the machinery and kindred trades, his genial disposition and kindly ways having made him many warm friends outside of his immediate circle, to whom his untimely death comes as a personal bereavement. He was an active member of the National Machine Tool Builders' Association, the Manufacturers' Club, Business Men's Club, and the Cincinnati Factory Colony Co. at Oakley, Ohio, where arrangements have been made to establish a large plant for his company.

Harry C. Hoefinghoff.

Mr. Hoefinghoff saw the Bickford Drill and Tool Co. grow under his management from a comparatively small concern, until at the time of his death it was the largest manufacturer of radial drills in the world. This success was due not alone to his energy and good judgment, but to the progressive ideas which he carried out, and the quick utilization of methods that appealed to him as being practicable, and which would improve his product or lessen its cost.

Mr. Hoefinghoff leaves a widow and three children, one boy and two girls.

* * *

PERSONAL.

E. M. McIlvain, formerly president of the Bethlehem Steel Co. has been elected president and general manager of the Robbins Conveying Belt Co., New York.

J. F. W. Bunsen, nephew of the late Prof. Bunsen, the inventor of the burner bearing his name, lately entered the employ of Muralt & Co., engineers and contractors, New York, and will take charge of their Southern office in Charleston, S. C.

W. J. Dolan, formerly connected with the Remington Typewriter Co. and later with L. C. Smith & Bros., Syracuse, N. Y., has accepted a position in the sales department of the Dayton Pneumatic Tool Co. and will have his headquarters in Pittsburg, Pa.

H. D. MacDonald, chief draftsman of the tool designing department and assistant master mechanic of the J. I. Case Threshing Machine Co., resigned his position, and on March 1 became connected with the International Harvester Co. on automobile construction work.

* * *

The dedication of the new Engineering Societies Building, New York, in which are housed the three founder societies, namely: American Society of Mechanical Engineers, American Institute of Electrical Engineers and the American Society of Mining Engineers, will be held April 16 and 17. The dedicatory program will include a joint meeting of the three societies at which there will be addresses by the presidents of the respective societies, and the reading of greetings from sister societies all over the world. Opportunities will be afforded for visiting plants of engineering interest in New York and vicinity, as is customary at the annual meetings of the A. S. M. E.

The date of the spring convention of the National Machine Tool Builders' Association, which is to be held at Fortress Monroe, Va., has been changed to May 14 and 15. The Hotel Chamberlain is the headquarters.

* * *

FRESH FROM THE PRESS.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JANUARY 30, 1905. The 18th annual report of the Interstate Commerce Commission. 728 pages 6 x 9 inches. Published by the U. S. Government, Washington, D. C.

AIR BRAKE CATECHISM. By Robert H. Blackall. 375 pages, 5 x 7 inches. 131 cuts. Published by Norman W. Henley & Son, New York.

This book is of the 21st edition, and is revised and enlarged. Mr. Blackall's work is so well known that a comprehensive review is unnecessary. It is a standard work on the air brake and is gotten up in the popular catechism style so well known in connection with educational books of this class. The book includes a pocket in which are three folding plates, and accompanying the book are two additional charts, one showing the modern Westinghouse high speed and signal equipment for freight service. To railroad men and others interested in the principles and operation of the air brake Mr. Blackall's work may be heartily recommended.

HENLEY'S 20TH CENTURY BOOK OF RECIPES, FORMULAS AND PROCESSES. Edited by Gardner D. Hiscox. 787 pages 6 x 9 inches. Published by Norman W. Henley & Son, New York. Price, bound in cloth, $3.00

This book contains nearly 10,000 selected scientific, chemical, technical and household recipes. It represents an enormous work in mere labor of compilation to say nothing of the work of editing. The list of subjects includes gilding, galvanizing, bronzing, tinning, silvering, plating, enamelling, varnishing, polishing, soaps, amalgams, alloys, solders, photographic formulas, lubricants, oils, inks, tanning, waterproofing, fireproofing, and many others too numerous to mention. The value of a reliable compilation of general formulas of the general character outlined above is too plain to need further comment.

QUESTIONS AND ANSWERS FROM THE GAS ENGINE. 277 pages, 5 x 7 inches. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $1.50.

This little book was compiled from the "Answers to Inquiries" column of the *Gas Engine* and includes the more interesting and valuable questions and answers that have been published in that journal for the past eight years. These inquiries relate to design, construction, operation and repair of gas and gasoline engines for stationary and automobile use, and in some instances are illustrated. An index facilitates the finding of any particular subject. The book should be of value to automobilists, motor boat users and the large general class of gas engine users throughout the country, a class that is rapidly increasing as the merits of the small internal combustion engines are recognized.

CONCRETE FACTORIES. Compiled by Robert W. Lesley. 152 pages 6½ x 9¾ inches, fully illustrated. Published for the Cement Age Co. by Bruce & Banning, New York. Price $1.00.

The work consists of a series of papers descriptive of the use of cements and concrete as applied to the construction of factory buildings. The book offers in condensed form the most complete review of the principles underlying reinforced concrete construction that has yet been published and it has the advantage of being presented in a way that is understandable by the layman as well as by the engineer. The work is a compilation of papers by men who have made a special study of the subject and the names included are Messrs. Walter Mueller, E. A. Trego, Henry H. Quimby, Emile Perrot, A. C. P. Turner, E. P. Goodridge, J. R. Worcester, Dean & Main, and other eminent authorities on concrete construction work.

THE RAILROAD POCKETBOOK, by Fred H. Colvin. 215 pages, 4 x 6 inches, illustrated. Published by the Derry-Collard Co., New York. Price $1.00.

This little book is a quick reference cyclopedia on railroad information. The subjects are arranged alphabetically; some are very briefly defined and others are given considerable space, according to the importance of the subject. It has been the aim to compile and define a list of subjects that occur most in railway work, and the definitions are not limited to word descriptions alone, but frequently are illustrated as well. For example, types of locomotive boilers are represented by a number of outline drawings and the same applies in general where the subject may be illustrated advantageously. The book is one that railway men will find convenient. It contains a number of valuable tables including weights of tires, tire shrinkage allowance, tire turning chart, etc., and is of a size that can be carried in the pocket without trouble. The work has not been paged consecutively but has been made up so that new matter can be added from time to time as conditions require. It is the intention of the publishers to keep the book up to date and to make it a complete pocket cyclopedia so far as possible within its field.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTE FOR THE YEAR ENDING JUNE 30, 1905. 576 pages, 6 x 9 inches, illustrated with over 100 engravings. Published by the United States Government, Washington, D. C.

The annual report of the Smithsonian Institute for a number of years has been a bulky volume, containing an account of the work accomplished by the Institute, its receipts and expenditures, and a voluminous compilation of scientific articles taken from various sources. The same general plan has been followed in the present report but the number of abstracted articles is considerably reduced so that the bulk of the work is considerably less than in former years. The abstracted reports include "New Measurements of the Distance of the Sun" by A. R. Hinks; "Photographing Lightning with a Moving Camera" by Alex. Larson; "The Tantalum Lamp" by W. VanBolton and O. Feuerlein; "Some Refinements of Mechanical Science" by Ambrose Swasey; "Progress in Radiography" by L. Gastine; "History of Photography" by Robert Hunt; "The Genesis of the Diamond" by Gardner F. Williams; "Gold in Science and in Industry" by G. F. Beilby; "Submarine Navigation" by William H. White; "Liberia" by Harry Johnston; "Geographic Result of the Tibet Mission" by Frank Younghusband; etc.

BULLETINS OF THE ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS. Volume 1, including bulletins Nos. 1 to 8 and circulars 1 and 2. 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

The bulletins contained in Volume 1 are "Tests on Reinforced Concrete Beams," by Arthur N. Talbot; "Tests of High Speed Steels on Cast Iron," by L. P. Breckenridge and Henry B. Dirks; "The Engineering Experiment Station of the University of Illinois," by L. P. Breckenridge; "Tests of Reinforced Concrete Beams, Series of 1905"; "Resistance of Tubes to Collapse," by Albert P. Carman and Morris L. Carr; "Holding Power of Railroad Spikes," by Roy I. Weber; "Fuel Tests of Illinois Coal," by L. P. Breckenridge, S. W. Parr and H. B. Dirks; "Tests of Concrete: I. Shear, II. Bond," by Arthur N. Talbot. These bulletins are without doubt the most valuable ever issued by the engineering department of a technical institution. They represent original investigation of a high order and the work is worthy of substantial encouragement. The bulletin of tests on high-speed tool steels on cast iron contains the first published tests of consequence that had been made in this country. Recent papers of technical interest are those on the resistance of tubes to collapse, and the tests of concrete and reinforced concrete beams. The engineering experiment station, it may be explained, is a department connected with the college of engineering. It was established in 1903 for the purpose of carrying on investigations along various lines of engineering, and for the study of problems of importance to professional engineers and to the manufacturing and industrial interests of the State.

MODERN AMERICAN LATHE PRACTICE. By Oscar E. Perrigo. 424 pages 6 x 9 inches. 314 illustrations. Published by Norman W. Henley & Son. Price $2.50.

The aim of the author was to present within a single volume the history and development of the lathe—the universal machine tool—with particular reference to the American designs and types. The author is peculiarly fitted to write an intelligent and well-thought out work of this character, both by reason of literary ability and his experience as a practical lathe builder, having been for a number of years superintendent of one of the oldest machine tool building concerns in New England. The first chapter is historical and traces the lathe from the earliest known times to the introduction of screw threading. In this chapter such devices as the spring-pole lathe, fiddle-bow lathe, foot-power lathe and other types that belong to the era before the advent of the steam engine are described and illustrated. It is from the spring-pole or "lath" used in the primitive machine for converting the reciprocating motion of the foot into rotary motion that we get the present name "lathe" applied to turning machines as a type. That the work is comprehensive is indicated by the headings of the following chapters, to wit: History of the Lathe up to the Introduction of Screw Threads; The Development of the Lathe Since the Introduction of Screw Threads; Classification of Lathes; Lathe Design: the Bed and its Supports; Lathe Design: the Head-stock Casting, the Spindle and the Spindle Cone; Lathe Design: the Spindle Bearings, the Back Gears and the Triple Gear Mechanism; Lathe Design: the Tail-stock, the Carriage, the Apron, etc.; Lathe Design: Turning Rests, Supporting Rests, Shaft Straighteners, etc.; Lathe Attachments; Rapid Change Gear Mechanisms; Lathe Tools, High-Speed Steel, Speeds and Feeds, Power for Cutting Tools, etc.: Testing a Lathe; Lathe Work; Engine Lathes; Heavy Lathes; High-Speed Lathes; Special Lathes; Regular Turret Lathes; Special Turret Lathes; Electrically Driven Lathes. The publisher has departed from the common practice of borrowing halftone electrotypes from the various makers of the tools illustrated, and has, instead, used line cuts throughout, thereby giving the book an individuality and tone that too often is sadly lacking in books of this character.

NEW TRADE LITERATURE.

D. SAUNDERS' SONS, Yonkers, N. Y. 1907 illustrated catalogue containing descriptions and price lists of pipe-threading machinery.

PITTSBURG AUTOMATIC VISE & TOOL CO., Pittsburg, Pa., has issued a set of unique blotters advertising their automatic vises.

NORTON GRINDING CO., Worcester, Mass. Leaflet announcing the Boston Automobile and Power Boat Show, March 9 to 16, at which the company exhibited specimens of ground crankshafts.

THE UNIVERSITY OF ILLINOIS, Urbana, Ill., has issued a leaflet giving information concerning the school of railway engineering and administration recently organized.

B. F. STURTEVANT CO., Boston, Mass., has issued Bulletin 125 describing and illustrating Class V S 5 vertical engines. Tables giving the principal dimensions and net horsepowers are included.

THE ROBERTSON MFG. CO., Buffalo, N. Y. 1907 Catalogue describing and illustrating various types of Robertson rapid cut power saws. Copy of the catalogue will be sent to all interested.

JEFFREY MFG. CO., Columbus, O. Bulletins illustrating coal and ashes handling machinery and grab bucket system, showing the machines installed in a number of plants.

L. H. GILMER & CO., Philadelphia, Pa. Catalogue No. 3, describing Gilmer endless belts, polishing machines and attachments, abrasive wheels, grinding materials, etc.

THE NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York, in its *Progress Reporter* for March, 1907, describes a Pratt & Whitney 16-inch toolmakers' lathe, some special planers, pneumatic clutches for planer drives, armor plate machinery, etc.

THE ELECTRIC CONTROLLER & SUPPLY CO., Cleveland, O. Bulletin No. 107 on Type G controllers describes details of construction and operation, and contains instructions for ordering, price list and other tables of specifications.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York. List No. 13 of second-hand metal-working machinery, among which is included railroad machinery, screw-cutting lathes, planers, shapers, drills, milling machines, grinding and polishing machines, etc.

CLEVELAND CITY FORGE & IRON CO., Cleveland, O., has published a book designed to set forth some of the manufactured products of the company. It also contains useful tables giving information relating to round and square bars and their connections. The book will be of value to engineers and builders.

THE NATIONAL ASSOCIATION OF MANUFACTURERS, New York, has sent us a pamphlet explaining what the association tries to be and what it tries to do for manufacturers. It explains the workings of the home and foreign departments, and concludes with a list of officers and directors of the association.

MONTGOMERY & CO., 105 Fulton Street, New York City. Tool catalogue No. 25, giving net prices printed in red ink. Specifications and illustrations of some of this company's many classes of tools are included. Prices of any tools not included in these pages will be submitted upon request.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has issued an artistic book entitled Crucibles—Their Care and Use. The purpose of this book is to inform the user of crucibles as to their nature and characteristics, and give him suggestions as to their care and handling. It gives much information on graphite and graphite crucibles, describes various fuels used in melting metals, gives the proportions of metal in commonly-used alloys, tells the freezing, fusing and boiling points of various substances and the specific gravity of various metals, and other allied information. All those interested in the melting of metals should obtain a copy of this book.

THE AMERICAN LOCOMOTIVE CO., 111 Broadway, New York City, has recently issued a pamphlet which illustrates and describes light locomotives (both steam and compressed air) adapted for the use of contractors, mines, logging roads, plantations and industrial plants, and for a wide range of service on light rails and poor road bed. The pamphlet contains 31 illustrations of different designs and types, and on the page opposite each illustration is a table giving the principal dimensions of designs of progressive weights and hauling capacities of the type illustrated. The last part of the pamphlet is devoted to engineering data and contains a number of very useful tables and formulas. The pamphlet is a complete record of the production of the company in locomotives of light power.

CONTENTS FOR APRIL.

The Drop Forge and Hardening Plant. E. H. McClintock 413
The Utilization of Labor 416
A Self-Regulating Brake 419
Visit of the Mechanical Engineers to Sandy Hook 420
Automobile Engine Building in a Steam Engine Plant 421
The Discipline of Demosthenes McGinnis. The Hired Man 424
Hurd and Haggin Marine and Railway Engine 425
Repairing a 17-foot Flywheel Arm. Walter Bixby 428
Recent Changes in Machine Shop, Worcester Polytechnic Institute. H. P. Fairfield 429
Some Good Things not in Common Use. E. R. Plaisted. 430
The Edgwick Works of Alfred Herbert, Ltd 431
Measuring Width of Flat on U. S. Standard Thread Tools Erik Oberg 432
A Casehardening Incident. E. R. Markham 434
Items of Mechanical Interest 435
Editorial 436
Principles of Design. Entropy 437
Governing Device for Internal Combustion Engines 440
Conclusions as to the Stability of Steel Frame Buildings 440
Effect of Duration of Stress on Strength and Stiffness of Wood 440
A Rapid Current Hot Water Heating System 441
Making Seamless Steel Tubes 441
Centrifugal Pumps 442
On the Art of Cutting Metals. Fred W. Taylor 445
Volume, Pressure and Horsepower of Blower Performance 448
Pneumatic Clamp Drilling Jig. O. C. Bornholt 449
Grinding a Large Crankshaft. J. C. Spence 450
Cam Curves. Arthur B. Babbitt 451
Expanding Tools. W. S. Marquis 453
Dimensioning Worm and Worm-wheel Drawings. Alpha 453
Designing a Pair of Spiral Gears. Chas. A. Heald 453
Where Quick Judgment Saved Dollars. Master Mechanic 454
Graduating in the Milling Machine and the Shaper. Donald A. Hampson 454
R. S. Solves a Problem 455
Tools for Bending and Threading in a Small Shop 455
Screw Machine Recessing Tool 456
Grinding Piston Rings on the Planer. C. F. Moore 456
How to Make a Saw. Max J. Oches 456
Bushing for Turning Odd Diameters in the Screw Machine. Frederick Walsleben 457
Safety Valve for Blast Pipes. George T. Coles 457
I Can't Draw but I Kin Whittle. Thomas Hill 457
Boring Tool for Milling Machine. R. P. Jorgensen 458
Scaffold on Wheels. A. D. Knauel 458
The Fundamental Principle of Proportioning Machine Parts. G. M. Strombeck 458
Shop Kinks 459
Shop Receipts and Formulas 460
How and Why 461
Machinery and Tools 462
Industrial Notes from Europe. Jas. Vose 468

MANUFACTURERS' NOTES.

Miami Machine Tool Co., Dayton, Ohio, manufacturer of the "Miami" lathes, has been obliged to move into a much larger factory.

Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, Ohio, manufacturer of lathes, is building an addition to its present shop.

Walcott & Wood Machine Tool Co., Jackson, Mich., is the successor to Geo. D. Walcott & Son. The president of the new concern is Mr. E. E. Wood.

Cincinnati Shaper Co., Garrard Ave. and Elam St., Cincinnati, Ohio, will make a large addition to its present plant. The addition includes a new warehouse.

M. Koyemann, Düsseldorf, Germany, states that he has made an agreement with the Windsor Machine Co., Windsor, Vt., to sell its Gridley automatic turret lathes in Germany.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, is making a large addition to its present plant and is adding another power station; 65 new machine tools are being installed.

Sterling Electric Motor Co., Dayton, Ohio, has broken ground for a new factory located at the corner of Second and Clinton Sts. The factory building and office will cover one entire block.

The Star Corundum Wheel Co., Ltd., Detroit, Mich., is now located in its new factory, 241-251 Cavalry Avenue, where it has a very complete equipment for the manufacture of abrasive wheels.

The Link-Belt Co. has acquired a new office location at 84 State Street, Boston, Mass., from which the future business of its chain drive department in New England will be directed.

The Bullard Machine Tool Co., 531 Broad St., Bridgeport, Conn., has recently appointed the Pacific Tool & Supply Co., 556 Howard St., San Francisco, agents for its product in California.

Illmer & Co., Cincinnati, Ohio, have opened an office at 310 Fourth National Bank Building where they will conduct a consulting business as gas engine experts, specializing in oil engines and high power gas engine design.

The Hisey-Wolf Machine Co., Cincinnati, Ohio, has purchased a plot of ground at the corner of Canal and Township Sts., where it will erect a new factory 165 x 245 feet, three stories high. The company expects to occupy the entire building.

Charles H. Besly & Co., 15-17-19-21 South Clinton St., Chicago, Ill. exhibited their Besly disk grinders and hand polishing wheels at Liege Exposition last year, and have been awarded medals for their exhibits.

The United States Census Bureau, Washington, D. C., is developing an extensive machine shop for experimental purposes, and often has occasion to consult catalogues of various manufacturers of machine tools, small tools, etc. The Bureau solicits all manufacturers of machine tools, etc., to send their catalogues for filing.

The S. Obermayer Co., Cincinnati, O., has made contracts for improvements for its plant on the western side of Evans Street, south of Eighth Street. The improvement consists of a two-story brick building 75 x 75 feet for manufacturing purposes and in which will be installed a 500-horsepower Greenwald Corliss engine with improved rope drive.

Williams, Brown & Earle, 918 Chestnut St., Philadelphia, Pa., have received a special order from the Baldwin Locomotive Works, whose entire blueprint plant was destroyed by the great fire of January 29, for a Williams, Brown & Earle perfecting machine arranged to print, wash, potash and dry blueprints at the rate of 12 to 15 square feet per minute and to deliver same ready for use.

The Electro Metallurgical Co., 157 Michigan Avenue, Chicago, Ill., was incorporated about six months ago and began the manufacture at Niagara Falls of high-grade ferro-alloys; is is now installing additional equipment there for materially increasing its output. This business includes that of the Willson Aluminum Co., Kanawha Falls, West Virginia, which was transferred to it in February. The New York offices are located at 79 Wall Street.

Ph. Bonvillain & E. Ronceray, Paris, France, will exhibit their molding machines at the meeting of the American Foundrymen's Association to be held in Philadelphia, May 20 to 24. Mr. E. Ronceray will take charge of the exposition, leaving Havre for the United States April 13. While here he will visit the principal machine tool manufacturers with a view of establishing connections for the sale of American machinery in Europe.

The American Blower Co., Detroit, Mich., has recently completed a large addition to its steel plate fan shop, and a large addition to its power plant and engine construction department is under way. Since putting the new vertical self-oiling engine on the market, the engine department has developed so greatly as to force an entire rearrangement of the plant.

The Samuel C. Tatum Co., Cincinnati, Ohio, is about to erect a large factory building 366 feet long, four stories and basement; also a foundry building 110 x 300 feet, with power plant, etc., to properly care for the large increase in its business. Since its establishment in 1859 the concern has been at John and Water Streets, but the new location is Colerain and Monmouth Avenues.

The Scranton & Co., New Haven, Conn., manufacturers of the Scranton improved upright power hammer and other specialties, have increased their manufacturing capacity in order to take care of their rapidly growing business. They expect soon to have all orders delivered complete and to accumulate a stock from which future orders can be promptly shipped.

The Fox Machine Co., 815-825 No. Front St., Grand Rapids, Mich., recently shipped good sized orders of machine tools, pattern shop equipment and general woodworking machinery to Japan, Italy and France. The company is constantly receiving small orders from nearly every civilized country on the globe. Domestic trade is held up very strong; its plant is running twenty-two hours per day and has been doing so for six months past.

The G. M. Yost Mfg. Co., Mechanicsburg, Pa., has moved its plant from Yonkers, N. Y., and its office from Waynesboro, Pa., to the above location. The company has secured a charter and is organized with the following officers: President, I. E. Yost; vice-president and general manager, G. M. Yost; secretary and treasurer, T. J. Kennedy. The company will manufacture a complete line of the Stevens and Snediker quick-acting vises, and in addition a full and complete line of regular machinists' vises.

The Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturers of portable electrical drills and grinders, has increased its capital stock to $100,000. The increase is to provide additional facilities to handle their rapidly growing business. This company enlarged its present factory about two years ago but has again outgrown it and will build an up-to-date plant, giving employment to about two hundred people.

The Northern Engineering Works, 26 Chene St., Detroit, Mich., crane manufacturers, is building an addition to its plant consisting of a one-story erecting building, 50 x 100 feet, in which electric crane trolleys will be built. This building will be served by a 10-ton electric traveling Northern crane. Another addition is a two-story building 30 x 50 feet which will serve as toolroom and storeroom. Both buildings are of brick and steel construction with saw-tooth roofs.

The Independent Pneumatic Tool Co., Chicago, Ill., has received a large order for "Thor" piston air drills and pneumatic hammers from the Wisconsin Engine Co., Corliss, Wis. The engine company made an exhaustive test extending over three months and including every make of pneumatic tools on the market. The awarding of the contract to the Independent Pneumatic Tool Co. is considered to be indorsement for greater efficiency and durability of the "Thor" tools than any of their competitors.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I., broke ground for its new factory on March 19, 1907. The building will be of brick construction, practically fireproof, covering 24,000 square feet of floor space, and increasing the company's manufacturing facilities seventy-five per cent. By means of these increased facilities the company expects to be better able to serve its patrons and to fill promptly all requirements in its line of tools for cutting screw threads. This company started in business thirty-seven years ago and is the pioneer machine screw tap maker of this country, having first put the machine screw tap on the market.

Van Rietschoten & Houwens, Rotterdam, have built new quarters expressly for the exhibition of machine tools. The building covers an area of about 11,000 square feet, and has a facade nearly 200 feet in length. The roof is more than half glass, making an extremely well-lighted building for the exhibition of machine tools. The new address is 554 Westzeedick. This is the third move made by the concern since it began business forty years ago. The concern makes a specialty of American machine tools and hopes that its new showrooms will materially assist in extending its trade.

de Fries & Cie. Akt.-Ges., Düsseldorf, Germany, had a prosperous business in 1906, the amount of sales showing an increase of 50 per cent as against 1905. The concern now employs nearly 900 people. Besides manufacturing machines of their own design, this concern is still importing large quantities of American machine tools, and it expects to increase American connections. The stock and showrooms have been considerably extended. In Milan it has without doubt the most beautiful showroom on the best site in that city, and a new showroom has been opened in Paris.

The Ohio Foundry Co., Dayton, Ohio, has organized a railroad company for the purpose of acquiring track facilities, and a charter has been granted for it under the name of the Ohio Sterling Railroad Co. The proposed switch will run into the new plant now being constructed. The machine shop is 110 feet by 168 feet with saw-tooth roof construction, brick walls and gravel roof. Part of the building will be two stories high. This building will be occupied by the motor shop. The foundry building will be 140 feet x 260 feet, and is to be a brick structure with wooden framing and gravel roof. The president